THE ROLE AND PERCEIVED VALUE OF MONITORING BY RANCHER-LED COLLABORATIVES IN THE INTERIOR WESTERN UNITED STATES

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A Thesis

Submitted in Partial Fulfilment

of the Requirements for the Degree of

Master of Science

in Environmental Sciences and Policy

Northern Arizona University

May 2022

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ABSTRACT

THE ROLE AND PERCEIVED VALUE OF MONITORING BY RANCHER-LED COLLABORATIVES IN THE INTERIOR WESTERN UNITED STATES

MICHAELA S. GOLD

Rangelands dominate the interior western U.S. where ranchers have long been the biggest land user. Due to a history of overexploitation from grazing, subsequent land degradation and complex challenges of rangeland management from fragmented landownership, there is high conflict between ranches and land management agencies. In order to deal with these challenges, a number of rancher-led collaborative groups have formed since the 1990s. These rancher-led collaboratives seek to reduce conflict by engaging a diverse set of stakeholders to make collective decisions for social, economic, and ecological problems. Due to the interdependency of ranches and rangeland function, it is important to understand the role and value of monitoring for these rancher-led collaboratives as one way to evaluate whether they use monitoring data to make better informed management decisions and allows us to see whether the outcomes of the agreed-upon management strategies by the collaborative are being achieved. Between June and August 2021, 19 interviews were conducted, representing 20 rancher-led collaboratives. Using semi-structured interviews and surveys, we explored the following questions: (1) are these collaboratives collecting monitoring data, and if so what role does it play in their work, (2) what monitoring variables they are collecting, and (3) how do they value and utilize their monitoring data. Three main trends emerged from this study: (1) Long-term trends and shorter-term monitoring data is needed to make decisions and understand the changes to the landscape as there is value in long-term trends, but also a need for shorter-term data that can be used for adaptive management. However, there is a lack of capacity and support for monitoring hindering

improvements in long and short term monitoring. (2) Due to formal monitoring being limited in scope, it is important to consider utilizing informal monitoring through observations by ranchers due to the slow pace of monitoring. There is also a need for different scales of monitoring to see what is happening beyond a collaboratives scope. (3) Ranchers are interested in science and data but find it hard to form trusting relationships in order to collaboratively monitor and share data with others, a challenge these collaboratives help to overcome. This study has implications for the future of rangeland management and monitoring as there is a clear opportunity to engage with rancher-led collaboratives across the West that all saw value in monitoring but for a variety of reasons struggle to use it to its full potential.

ACKNOWLEDGMENTS

I would like to thanks the individuals that participated in this study and the rancher-led collaboratives they represent. This study would not have been possible without their willingness to participate and share the stories of their collaboratives work. Thank you to all those who provided guidance and advice through this study from the original idea to the final product, specifically Dr. Hailey Wilmer, Dr. Mark Brunson, Dr. Zack Wurtzebach, Chris West, and Seth Gallagher. Thank you to all of the faculty and graduate students of the Environmental Sciences & Policy program at NAU. Without your support and many hours of struggling together, I would not be where I am today, specifically I would like to thank Dr. Rebecca Best, Iris Garthwaite, Leah Marshall, Jessica Archibald, and Zoe Klein. Thank you to my committee and advisors, Dr. Clare Aslan, Dr. Sara Souther, and Dr. Diana Stuart, for your guidance and allowing me to create a study I was passionate about with full support. Finally, I would like to thank my fiancé, Chris, for your many hours of listening to me talk about ranching, collaboration, and monitoring, three things you know nothing about but have always supported my passions and interests.

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PREFACE

This thesis is comprised of five chapters. Chapter one provides an introduction to the research as well as a review of the literature. Chapter two is a comprehensive explanation of the methods required by Northern Arizona University. Chapter three is formatted as a journal article to be submitted for peer-review publication in the Rangeland Management and Ecology journal. Chapter four is a conclusion of the thesis. Chapter five is the literature cited of the thesis. As a result of following formatting requirements for Northern Arizona University, some redundancy exists between the chapters.

CHAPTER 1 - INTRODUCTION

Across the western US, rangelands dominate the arid and semi-arid landscape, covering around 761 million acres and making up 31% of the total US land area (Havstad et al., 2007, 2009) and about 70% of the western U.S. (West, 2003). Rangelands occur across numerous habitat types, including grasslands, shrublands, woodlands, wetlands, and deserts (Sayre, 2017). Since rangelands are largely undeveloped, they provide habitat connectivity and migration corridors for wildlife, while simultaneously supporting a variety of ecosystem services including food, water, recreation, religious sites, and more (Brunson and Huntsinger, 2008; Gosnell and Travis, 2005; Havstad et al., 2007). Rangelands are also complex social-ecological systems where livestock (cattle and sheep) ranchers often have multigenerational ties to particular land parcels, in some cases private land owned by the ranchers, but also public lands that they rely on for enough space to graze their livestock (Brunson and Huntsinger, 2008).

After the introduction of livestock in the late 1800s, western US rangelands were overexploited for grazing through the early twentieth century, with domestic livestock exceeding the historic number of native ungulates (Souther et al., 2019). Due to this overexploitation, rangelands have been in a condition of degradation for several decades (Briske, 2017; Sayre, 2017). Conflict over rangeland management became more prevalent in the 1940s due to this overexploitation and degradation, which led to arguments between ranchers and federal land management agencies over stocking rates and grazing fees (Merrill, 2002; Sayre, 2017). Despite this conflict, ranchers rely on well-functioning and healthy rangelands to continue grazing their cattle and must respond to changing environmental conditions through their management practices in order to retain those permits (Brunson and Huntsinger, 2008), and in turn the future of their livelihoods. Due to their reliance on grazing permits on public land, ranchers also have

an interest in demonstrating to public land managers their commitment to sustainable management of these rangelands (Charnley et al., 2014; Wilmer et al., 2018). Ranches themselves are also ecologically important as these private lands, in addition to what is already provided by rangelands, prevent further subdivisions of western landownership and are part of wildlife migration corridors (Brunson and Huntsinger, 2008; Gentner and Tanaka, 2002; Gosnell and Travis, 2005; Sayre, 2017).

To reduce conflict and improve management strategies, a number of rancher-led collaboratives, examples of a broader management tool referred to as community-based collaboration, have formed since the 1990s to improve rangeland management strategies. Many such collaboratives came together because of frustration with federal agency regulations on public land hindering their ability to make a living (Sheridan et al., 2014). These collaboratives seek to reduce conflict by engaging a diverse set of stakeholders (including ranchers, federal and state land agencies, environmental NGOs, and local communities) to make collective decisions for social, economic and ecological problems (Fernandez-Gimenez et al., 2005; Fernandez-Gimenez and Ballard, 2011; Koontz and Thomas, 2006). These stakeholders often join because they share similar frustrations about public land management in the West (Cawley and Freemuth, 1997; Nie, 2008; Sheridan et al., 2014).

Prior to the formation of many community-based collaboratives in the 1990s, there was recognition in the 1980s that the "command and control management", a top-down approach of state and federal land management agencies (Allen, 2006), that dominated much of the 1970s was not working (Bestelmeyer and Briske, 2012). While collaboration in general has become a key management strategy for natural resources since the 1990's, it has been met with both promise and skepticism (McKinney and Field, 2008). However, it is important to note that

proponents of collaboration do not suggest that collaboration by itself is a solution to these problems but is believed to be needed in order to create more durability in management through stakeholder engagement (Yaffee and Wondolleck, 2003).

Due to the interdependency of ranches and rangeland function, it is important to understand how rancher-led collaboratives are making decisions related to ecological function, economic considerations of their ranching practices, and the social implications of working together. Monitoring is essential as a tool to understand the effectiveness of management decisions and when to adapt or modify those strategies (Bestelmeyer et al., 2019; Fernandez-Gimenez and Ballard, 2011; Muñoz-Erickson et al., 2010; Sayre, 2017; Sheridan et al., 2014; Wilmer et al., 2018). Monitoring is often defined as involving the collection of data on ecological, economic and social indicators that is intended to answer questions related to management (Fernandez-Gimenez and Ballard, 2011).

On rangelands, monitoring is not simple due to their structural and functional diversity, which means choosing the appropriate indicators is challenging (West, 2003). Additionally, the structure of a monitoring plan must depend on the management actions or questions being asked (West, 2003). Due to the complexity and variability of rangelands, there is a need to not just monitor the ecological impacts of decisions but also the social and economic impacts (Gay, 1989; West, 2003). In an examination of collaborative environmental management in general, Yaffee & Wondelleck (2003) found that there is a lack of focus on the environmental outcomes and rather they focus on more efficient processes, better relationships, and communication, but they agreed that these process outcomes do not show whether the actual social outcomes are being achieved.

For these collaboratives, collecting monitoring data not only provides guidance for decision-making but also helps with internal accountability and external credibility (Fernandez-Gimenez & Ballard 2011; Harding and Moote 2005). In order to make decisions about how best to manage these lands, monitoring can help rancher-led collaboratives learn about the impact of their management decisions on the ecosystem (Fernandez-Gimenez & Ballard, 2011; Daniels & Walker, 2001). Perhaps the biggest unknown is what to monitor and how that can or should be used to adapt management decisions (Fernandez-Gimenez & Ballard, 2011). In an ideal situation a rancher-led collaborative would be monitoring throughout its entire process, and once they are able to determine the outcomes of their management decisions, the collaborative group would know whether it needs to adapt its plans. There is also a need for long-term monitoring of ecosystems due to the slow change of rangelands (Lovett et al., 2007) that may occur in response to decision-making, an opportunity for rancher-led collaboratives to be the entity that sustains that monitoring due the fact that they themselves persist on the landscape as landowners for many generations. Additionally, there is also a social benefit that can come from rancher-led collaborative monitoring and data collection as a potential alternative for researchers and agencies that need data but lack capacity as well as engaging different stakeholders through a process that can build social capacity in a community (Conrad and Daoust, 2008; Pattengill-Semmens and Semmens, 2003). However, monitoring is costly, and it is often underfunded by collaboratives that lack internal funding and volunteer support (Byron and Curtis, 2002; Fernandez-Gimenez and Ballard, 2011; Whitelaw et al., 2003).

Barriers, such as funding, hinder the collection and use of monitoring data on the ecological function and social dynamics of a collaborative's efforts. And while there are hundreds of community-based collaborative efforts taking place across the western US (Western

Collaborative Conservation Network, 2020), there is criticism that collaboratives are "unproven experiments," providing more reason to evaluate the effectiveness of collaborative management (Kenney, 200AD; Muñoz-Erickson et al., 2007). Often efforts by collaboratives to improve environmental conditions start out as experiments, and without monitoring these efforts, we are left with only anecdotes about whether such experiments were helpful or not (Sheridan et al., 2014). There is significant knowledge and research around the key characteristics of successful collaborative environmental management to reach social and process outcomes, such as trust, learning, effective and adaptive processes, clearly defined rules, and group participation in decision-making (Bestelmeyer et al., 2019; Ostrom, 2009, 1990; Wondolleck and Yaffee, 2000). However, there is a need to expand our understanding of the ecological, social, and economic outcomes from these collaborative efforts in order to truly comment on the effectiveness of collaboration as a strategy to improve management (Koontz and Thomas, 2006; Reid et al., 2010).

Currently, there is limited information on what monitoring data is being collected by rancher-led collaboratives across the US but there is evidence that at least some collaboratives are actively engaged in collecting monitoring data (Fernandez-Gimenez and Ballard, 2011). While previous efforts have evaluated the effectiveness of specific rangeland collaboratives to reach desired social and ecological outcomes (e.g., Munoz-Erickson et al., 2010; Wilmer et al., 2018; Allen 2006) none have specifically analyzed the role and value that rancher-led collaboratives across the interior West place on monitoring. There is a clear need to understand what monitoring data are being collected by rancher-led collaboratives and the role and value they place on that data. Knowing what monitoring data are being collected by rancher-led collaboratives and determining whether they use monitoring data to make better informed

management decisions allow us to see whether the outcomes of the agreed-upon management strategies by the collaborative are being achieved (Conley and Moote, 2003; Reid et al., 2010; Shackleton et al., 2010).

The study seeks to provide insights about how rancher-led collaboratives value ecological, social and economic monitoring data and the role of those data in their collaboratives work, including management decisions to reach desired goals and objectives. As more collaborative groups emerge to manage land and natural resources, understanding the prevalence and use of monitoring data to inform decision-making is one way to evaluate the effectiveness of community-led multi-stakeholder collaboratives to reach their goals (Fernandez-Gimenez and Ballard, 2011). Understanding how ecological, social, and economic monitoring data are collected and used, and the role and perceived value of those data for rancher-led collaboratives, can inform the management of rangelands that encompass both public and private lands, wherein management falls to both the ranchers and the public land managers.

RESEARCH QUESTIONS

This thesis will seek to address the following research questions about the monitoring efforts of rancher-led collaboratives across the interior western US:

1. Are rancher-led collaboratives across the interior West collecting monitoring data (ecological, social, and/or economic)?
    a. If so, what role does monitoring play in their work and what conditions and factors influence their ability to adopt and carry out ecological, social, and economic monitoring?
    b. If not, for what reasons do they not collect and use monitoring data?

2. For the rancher-led collaboratives that are carrying out monitoring, what variables and corresponding metrics are they collecting?
3. How do rancher-led collaboratives across the interior West that are carrying out monitoring value and utilize monitoring data for their collaborative group?
    a. What barriers, challenges or successes exist to utilizing that monitoring data?

CHAPTER 2 - METHODS

STUDY AREA

This projected focused on the interior western United States, which is a rangeland-dominated region. It includes US Forest Service Regions 1, 2, 3, and 4. Public land ranching is more concentrated in this area than any other part of the country, making it an ideal area to study rancher-led collaboratives (York et al., 2019). This area is also known for complex land management because of the fragmented land ownership that exists in these regions (Figure 1).

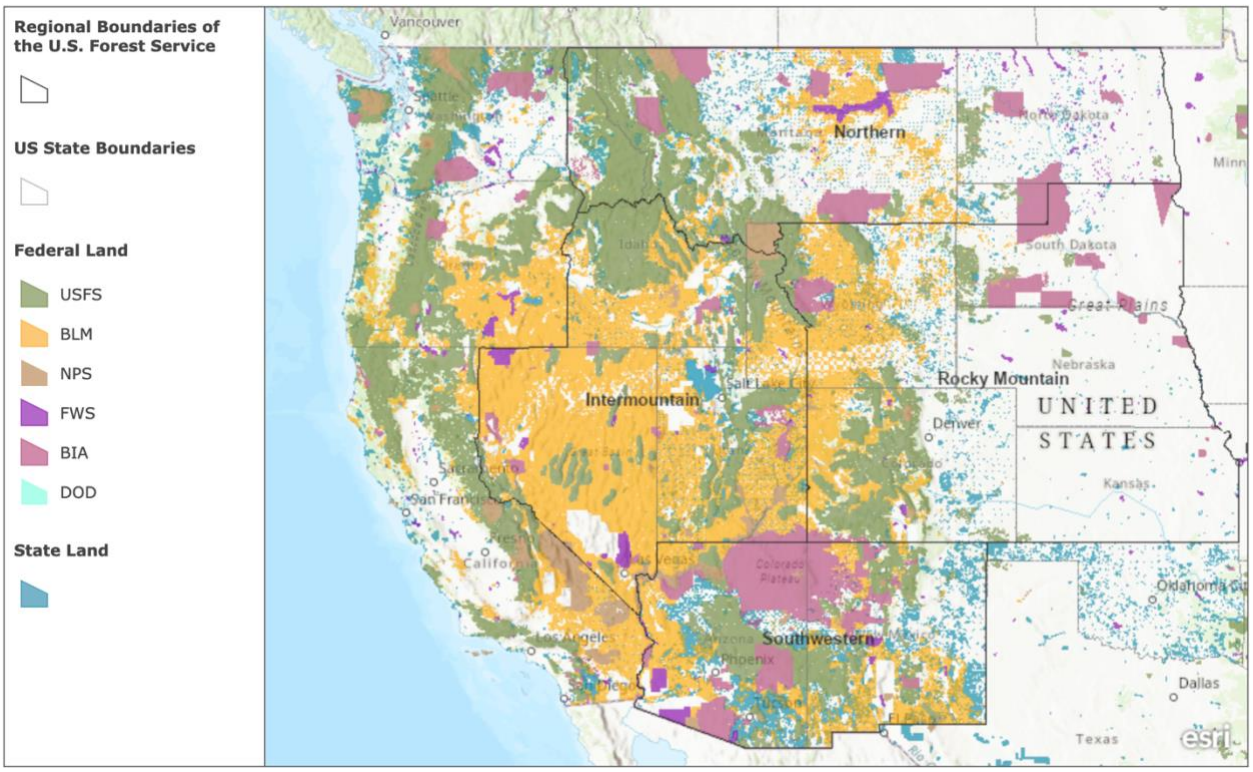

Figure 1. Land Ownership in the United States, with Forest Service Regions 1-4 outline - White space indicates land that is not federal or state land. (Source: Esri, USGS | Esri, HERE, Garmin, FAO, NOAA, USGS, EPA)

PARAMETERS AND PARTICIPANT SELECTION

Rancher-led collaboratives selected for this study fit three criteria: (1) they were started by one or more ranchers [although the rancher does not need to be currently leading the group, they do

need to be actively participating], (2) they were a community-based collaborative[1], and (3) they included at least one working ranch that is actively grazing cattle on public land in the interior western US and/or includes stakeholders from a state/federal land management agency.

Through purposive and snowball sampling techniques (Biernacki and Waldorf, 1981; Patton, 2002), I identified 24 rancher-led collaboratives (Appendix 1) that meet these parameters through internet searches, suggestions from researchers familiar with rangeland management, and recommendations from respondents. All 24 rancher-led collaboratives were contacted with a request to participate in this study. As this study focused on rancher-led collaboratives, it does not represent the ranching community in its entirety, since not all ranchers belong to collaboratives (McKinney and Field, 2008).

DESIGN AND ADMINISTRATION: INTERVIEWS AND SURVEYS

This research utilized a mixed-methods approach, using interviews and surveys, to understand the role of monitoring data for rancher-led collaboratives in the interior West and its value to these collaboratives.

Interviews

The contacts identified for each rancher-led collaborative were emailed with a request to participate in this study. This outreach email included an explanation of the study and what their participation would include. The interviews were semi-structured to allow for the conversation to evolve based on answers and topics that arose. The interview guide was reviewed by thesis

[1] (using the summarized definition from the Community-Based Collaboratives Research Consortium): a group that has been convened voluntarily from within the local community to focus on a resource management issue(s) involving public lands; brought together by a shared desire to influence the protection and use of natural resources through recommendations or direct actions that will impact the management of the resource; utilizes a decision-making process that requires participation by local stakeholders (Moote et al. 2000)

committee members, Drs. Stuart, Aslan, and Souther, as well as Drs. Hailey Wilmer and Mark Brunson, both rangeland social scientists. The interview was focused on answering the first and third research questions above and asked questions about: the history of the collaborative, how management decisions are made and projects/programs are decided on, how they value and perceive monitoring data and how it is or is not utilized. All interviews were conducted between June and August 2021. Each collaborative was asked to provide 1-2 individuals, hereafter referred to as "respondents," with the most in-depth knowledge about each rancher-led collaborative and their monitoring efforts. These respondents were asked specifically to respond to questions in their role as a stakeholder on behalf of their collaborative and they were asked to clearly state if a specific response was their personal perspective so it could be analyzed separately.

Each interview lasted between 1-2 hours, and all interviews except one were conducted and recorded over zoom. The C – O interview was conducted in person but was still recorded through zoom and transcribed in the same way as the other interviews. The recordings were automatically transcribed using the zoom cloud software. The transcripts were coded for anonymity, per IRB rules, and then imported in to MAXQDA 2022 software (VERBI Software, 2021) for analysis. Respondent 17 asked to review their transcript, which resulted in a second conversation over the phone to clarify a few points from their interview; those notes were added to their transcript for analysis.

A total of 19 interviews were conducted, representing 20 collaboratives, and including 21 respondents. Three collaboratives provided two respondents; two collaboratives had those two respondents participate in the same interview, and one collaborative had two respondents that participated in separate interviews due to scheduling needs. Two respondents were the main

contacts/the individuals with the most knowledge of two collaboratives and thus represented both during their interviews (Table 1).

Respondent	Interview	RLC representing	Respondent Background	Respondent – Male/Female	Respondent – Age Range
1	I – 1	C – A	Rancher	Female	20 – 40
2	I – 2	C – B	Scientist/Rancher	Male	20 – 40
3	I – 3	C – C	Scientist/Rancher	Male	20 – 40
4	I – 4	C – D	Rancher	Female	40 – 60
5	I – 5	C – E	Scientist	Male	40 – 60
6	I – 6	C – F	Rancher	Male	40 – 60
7	I – 7	C – G	Rancher/Scientist	Female	20 – 40
8	I – 8	C – H	Rancher/Scientist	Male	20 – 40
9	I – 9	C – I	Rancher	Male	60 +
10	I – 10	C – J C – S	Rancher/Scientist	Female	20 – 40
11	I – 11	C – R	Scientist	Female	20 – 40
12	I – 12	C – K	Scientist	Male	20 – 40
13		C – K	Scientist	Female	20 – 40
14	I – 13	C – L	Rancher	Male	20 – 40
15	I – 14	C – L	Scientist	Female	20 – 40
16	I – 15	C – M	Scientist	Male	20 – 40
17	I – 16	C – N C – T	Rancher	Female	40 – 60
18	I – 17	C – O	Rancher	Female	60 +
19		C – O	Scientist	Female	20 – 40
20	I – 18	C – P	Scientist	Female	20 – 40
21	I – 19	C – Q	Rancher/Scientist	Male	60 +

Table 1. Respondent Attributes & Corresponding Rancher-Led Collaborative (Note: RLC – rancher-led collaborative)

Confidentiality & Data Protection (per IRB approval):

All interviews were conducted over zoom and recorded. Transcripts were created through the zoom audio transcription feature. After each transcript was created, transcripts were reformatted to delete unnecessary spaces, which happen frequently in a zoom transcript, and respondent names were obscured to maintain confidentiality. All video recordings and original zoom transcripts (which included the respondent's name) were saved to a secure drive hosted by NAU along with the document that contains all respondent's names and the de-identified names assigned to them. All transcripts, once de-identified, were uploaded into MAXQDA. The audio

files were also uploaded into MAXQDA so they could be referenced when going through each transcript if needed. These measures were in accordance with IRB approval (IRB project number 1721984-2).

Surveys

Each interview was followed-up by a request to provide some additional information on the collaborative's attributes and to complete a survey.

In order to answer the second research question, I provided each collaborative with a survey which was a spreadsheet to fill out the following information: (i) name of monitoring variable or category, (ii) the type of data (social, ecological, economic), (iii) what data is being collected for that variable or category, (iv) are the data collected on public land, private land, both, or n/a, (v) how often are the data collected, (vi) who collects these data, (vii) who analyzes the data, (viii) what is the data used for, (ix) who owns/manages the data from this variable or category, (x) is the collaborative required to collect these data? If so, by whom? In the same request, I asked for the landownership breakdown of the area served for the collaborative.

Some collaboratives offered existing materials that contained this information. In those cases, I examined those materials and entered the information in the spreadsheet myself based on those documents.

DATA ANALYSIS

Interview Analysis

Interviews were recorded, transcribed, and analyzed using MAXQDA, a qualitative analysis tool, to code trends determined based on previous research, and later trends that

emerged from the interviews (Corbin and Strauss, 2008; Wurtzebach, 2018). This analysis process is guided by grounded theory, originally developed by Glaser and Strauss (1967) and Strauss and Corbin (1990), which attempts to uncover current trends while also understanding how the study subjects respond to changes in those trends and the effects of their actions. (Corbin and Strauss, 1990). I utilized this approach because it is used to identify trends or themes that emerge from the text itself and then links those to more formal theories (Bernard, 2006).

I completed the following steps to analyze the interviews (Bernard, 2006; Strauss & Corbin, 1990):

Step 1. I produced transcripts of all interviews; as each interview was conducted I took notes on key trends. If a new key trend or finding came through, that information was used to inform subsequent interviews (Corbin & Strauss, 1990).

Step 2. I used inductive coding, a form of coding where you allow your understanding to emerge from the text (Bernard, 2006), in this step as this is a key exploratory and discovery phase. Some in vivo coding, using actual phrases in the interviews to create a code (Strauss & Corbin 1990), occurred in this step as well. While my background in rangeland management, collaborative conservation, and ecological & socio-economic monitoring helped to identify some initial themes, additional themes were identified as they emerged from the text (Bernard, 2006). Five interviews were coded as part of the initial coding process. Once that initial "sample" of text was coded, I reviewed the codes to determine if any codes should be combined or separated into sub-codes and checked the codes emerging against my research questions to ensure they related back to the purpose of this study. From this process, an initial codebook was developed.

Step 3. Using the trends developed in Step 2, all interviews were coded, and I re-coded those coded during Step 2 as part of the iterative process of grounded theory (Strauss and Corbin,

2008). Theory notes (after Corbin & Strauss 1990) were used in this step, in order to link codes together as well as note trends that were emerging. During this step some codes were added or modified and any interviews that had already been coded were revisited to include these changes. Step 4. I conducted a second round of coding where subcodes were added to each main trend in order to further identify the similarities and differences amongst the respondents. This step assisted in continuing to make comparisons between the respondents as well as looking for the patterns and variations emerging (Corbin & Strauss, 1990).

A total of 1,488 codes exist for this MAXQDA project. Many are subcodes used to categorize excerpts to find the similarities and differences amongst the codes. A number of codes are also descriptive, such as the background of each collaborative, the respondent's background, data drivers, and data use. These codes were pulled and used to create tables in the results section.

This study does not attempt to evaluate the ecological improvements from these rancher-led collaboratives and thus I do not draw any conclusions about which collaborative's monitoring or outcomes are better than another. While every attempt was made to capture all responses from the respondents in the coding and analysis, it is possible that a respondent's response was missed or misinterpreted. Thus, any information in the results should not be taken as indicating that other respondents would not agree with a statement, but rather that it was not apparent in their semi-structured interview.

Survey Analysis

In order to answer the second research question, for the rancher-led collaboratives that are carrying out monitoring, what variables and corresponding data are they collecting?, the monitoring variable spreadsheets were analyzed. The entries were placed into three basic

categories, economic, social, and ecological to provide consistency across the monitoring variables and enable statistical analysis (Table 2). Due to limitations in sample size, I was only able to use three categories and was not able to conduct analyses on more specific categories such as those under the ecological category like habitat improvement. These categories were determined after review of all the entries submitted by collaboratives, and double-blind coding was used to reach agreement on these categories best representing the variables submitted. Jessica Archibald, a PhD student in the School of Earth & Sustainability at NAU, participated in the double-blind coding along with me. After both of us coded the variables to these larger categories, they were reviewed and where there was disagreement we discussed and came to an agreement on the most suitable category.

Category	Examples of original variables
Economic	Forage Availability/Production for Livestock, Funding/Support
Social	Community/Education, JEDI, Participation/Volunteers, Reach/Impact
Ecological	Carbon, Precipitation, Stream Flow, Land Stewardship, Number of Acres Conserved/Protected, Easement Monitoring, Vegetation, Riparian, Wildlife, Wildfire Management, Acres Enhanced, Miles of Fence Removed, Invasive Species Management, Prescribed Burn Acres, Birds, Fish, Large Mammals, Small Mammals, Carcass Removal or #, Predator Population

Table 2. Monitoring Variables Categories. Examples of the original monitoring data corresponding to each category (economic, social, and ecological) are provided

The following questions were explored using the information provided by each rancher-led collaborative: (1) Is majority landownership predictive of the data that are collected? (2) Is there a significant relationship between whether at least some of the data are required by an outside entity and whether the data are ecological, social or economic? (3) If a collaborative collects data in one of the main categories (ecological, social, economic), is this significantly predictive of whether they also collect data in another main category? (4) Is there a significant relationship between who is involved in the data collection and whether the data are ecological, social, or economic?

The data were analyzed in RStudio (R Version 4.0.4). The response data were treated as a binomial ‘yes’ and ‘no’ response against various predictors used to answer the questions above. Since these are categorical data, the data were analyzed using generalized linear models with a binomial error distribution. Data were considered significant if the p-value was below 0.05.

CHAPTER 3 – JOURNAL ARTICLE

INTRODUCTION

Across the western U.S., rangelands dominate the arid and semi-arid landscape, covering around 761 million acres and making up 31% of the total U.S. land area (Havstad et al., 2009, 2007) and about 70% of the western U.S. (West, 2003). Rangelands occur across numerous habitat types, including grasslands, shrublands, woodlands, wetlands, and deserts (Sayre, 2017). Since rangelands are largely undeveloped, they provide important habitat connectivity and migration corridors for wildlife, while simultaneously supporting a variety of ecosystem services, including food, water, recreation, religious sites, and more (Brunson and Huntsinger, 2008; Gosnell and Travis, 2005; Havstad et al., 2007). Rangelands are also complex social-ecological systems where livestock (cattle and sheep) ranchers often have multigenerational ties to particular land parcels, in some cases private land owned by the ranchers, but also public lands that they rely on for enough space to graze their livestock (Brunson and Huntsinger, 2008).

After the introduction of livestock in the late 1800s, western U.S. rangelands were overexploited for grazing through the early twentieth century, with domestic livestock exceeding the historic number of native ungulates (Souther et al., 2019). Due to this overexploitation, rangelands have been in a condition of degradation for several decades (Briske, 2017; Sayre, 2017). Conflict over rangeland management became more prevalent in the 1940s due to this overexploitation and degradation, which led to arguments between ranchers and federal land management agencies over stocking rates and grazing fees (Merrill, 2002; Sayre, 2017). Despite this conflict, ranchers rely on well-functioning and healthy rangelands to continue grazing their cattle and must respond to changing environmental conditions through their management practices in order to retain those permits (Brunson and Huntsinger, 2008), and in turn the future

of their livelihoods. Due to their reliance on grazing permits on public land, ranchers also have an interest in demonstrating to public land managers their commitment to sustainable management of these rangelands (Charnley et al., 2014; Wilmer et al., 2018). Ranches themselves are also ecologically important as these private lands, in addition to what is already provided by rangelands, prevent further subdivisions of western landownership and are part of wildlife migration corridors (Brunson and Huntsinger, 2008; Gentner and Tanaka, 2002; Gosnell and Travis, 2005; Sayre, 2017).

To reduce conflict and improve management, a number of rancher-led collaboratives, examples of a broader management tool referred to as community-based collaboration, have formed since the 1990s to improve rangeland management strategies. Many such collaboratives came together because of frustration with federal agency regulations on public land hindering their ability to make a living (Sheridan et al., 2014). These collaboratives seek to reduce conflict by engaging a diverse set of stakeholders (including ranchers, federal and state land agencies, environmental NGOs, and local communities) to manage shared resources and make collective decisions for social, economic and ecological problems (Fernandez-Gimenez and Ballard, 2011; Koontz and Thomas, 2006; Sheridan et al., 2014). These stakeholders often join because they share similar frustrations about public land management in the West (Cawley and Freemuth, 1997; Nie, 2008; Sheridan et al., 2014).

Prior to the formation of many community-based collaboratives in the 1990s, there was recognition in the 1980s that the “command and control management”, a top-down approach of state and federal land management agencies (Allen, 2006), that dominated much of the 1970s was not working (Bestelmeyer and Briske, 2012). While collaboration in general has become a key management strategy for natural resources since the 1990’s, it has been met with both

promise and skepticism (McKinney and Field, 2008). However, it is important to note that proponents of collaboration do not suggest that collaboration by itself is a solution to these problems but is believed to be needed in order to create more durability in management by engaging stakeholders (Yaffee and Wondolleck, 2003).

Due to the interdependency of ranches and rangeland function, it is important to understand how rancher-led collaboratives are making decisions related to ecological function, economic considerations of their ranching practices, and the social implications of working together. Monitoring is essential as a tool to understand the effectiveness of management decisions and when to adapt or modify those strategies (Bestelmeyer et al., 2019; Fernandez-Gimenez and Ballard, 2011; Muñoz-Erickson et al., 2010; Sayre, 2017; Sheridan et al., 2014; Wilmer et al., 2018). Monitoring is often defined as involving the collection of data on ecological, economic and social indicators that is intended to answer questions related to management (Fernandez-Gimenez and Ballard, 2011). On rangelands, monitoring is not simple due to their structural and functional diversity, which means choosing the appropriate indicators is challenging (West, 2003). Additionally, the structure of a monitoring plan must depend on the management actions or questions being asked (West, 2003). Due to the complexity and variability of rangelands, there is a need to not just monitor the ecological impacts of decisions but also the social and economic impacts (Gay, 1989; West, 2003).

For these collaboratives, collecting monitoring data not only provides guidance for decision-making but also helps with internal accountability and external credibility (Fernandez-Gimenez & Ballard 2011; Harding and Moote 2005). In order to make decisions about how best to manage these lands, monitoring can help rancher-led collaboratives learn about the impact of their management decisions on the ecosystem (Fernandez-Gimenez & Ballard, 2011; Daniels &

Walker, 2001). In an ideal situation a rancher-led collaborative would be monitoring throughout its entire process, and once we are able to determine the outcomes of its management decisions, the collaborative would know whether it needs to adapt its plans. There is also a need for long-term monitoring of these ecosystems due to the slow change of rangelands (Lovett et al., 2007) that may occur in response to decision-making, an opportunity for rancher-led collaboratives to be the entity that sustains that monitoring due the fact that they themselves persist on the landscape as landowners for generations. Additionally, there is a social benefit that can come from rancher-led collaborative monitoring and data collection as a potential alternative for researchers and agencies that need data but lack capacity as well as engaging different stakeholders through a process that can build social capacity in a community (Conrad and Daoust, 2008; Pattengill-Semmens and Semmens, 2003). However, monitoring is costly, and it is often underfunded by collaboratives that lack internal funding and volunteer support (Byron and Curtis, 2002; Fernandez-Gimenez and Ballard, 2011; Whitelaw et al., 2003).

Currently, there is limited information on what monitoring data is being collected by rancher-led collaboratives in the U.S. but there is evidence that at least some groups are actively engaged in collecting monitoring data (Fernandez-Gimenez and Ballard, 2011). While previous efforts have evaluated the effectiveness of specific rangeland collaboratives to reach desired social and ecological outcomes (Allen, 2006; Muñoz-Erickson et al., 2010; Wilmer et al., 2018) none have specifically analyzed the role and value that rancher-led collaboratives across the interior West place on monitoring. There is a clear need to understand what monitoring data are being collected by rancher-led collaboratives and the role and value they place on that data. Knowing what monitoring data are being collected by rancher-led collaboratives and determining whether they use that monitoring data to make better informed management

decisions allow us to comment on the effectiveness of collaboration as a strategy to improve management (Koontz and Thomas, 2006; Reid et al., 2010).

The study seeks to provide insights about how rancher-led collaboratives value ecological, social and economic monitoring data and the role of those data in their collaboratives work, including management decisions to reach desired goals and objectives. Specifically, this research asks: (1) Are rancher-led collaboratives in the interior West collecting monitoring data and what role does it play in their work; (2) if so, what data are they collecting; and (3) how are they valuing and utilizing those data they collect? Understanding how ecological, social, and economic monitoring data are collected and used, and the role and perceived value of those data for rancher-led collaborative, can inform the management of rangelands that encompass both public and private lands, wherein management falls to both the ranchers and the public land managers.

METHODS

Study Location

This study focuses on rancher-led collaboratives in the interior western US, which is defined by Forest Service regions 1, 2, 3, and 4. Public land ranching is more concentrated in this area than any other part of the country, making it an ideal area to study rancher-led collaboratives (York et al., 2019). This area is also known for complex land management because of the fragmented land ownership that exists in these regions (Figure 2).

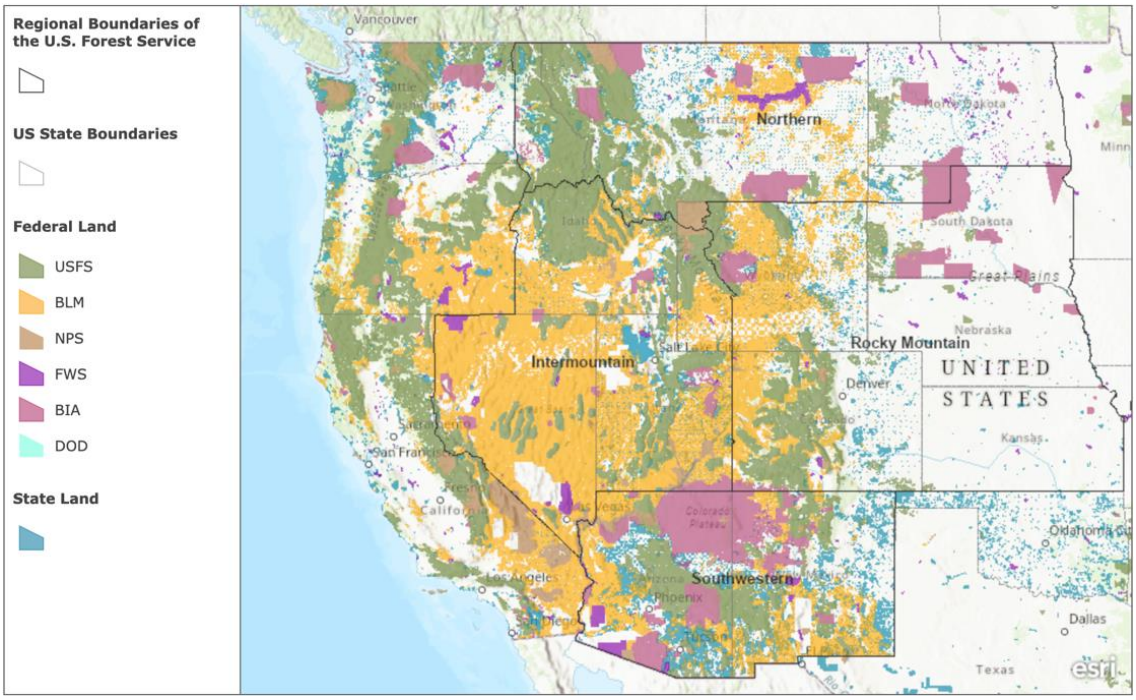

Figure 2. Land Ownership in the United States, with Forest Service Regions 1-4 outline - White space indicates land that is not federal or state land. (Source: Esri, USGS | Esri, HERE, Garmin, FAO, NOAA, USGS, EPA)

Participant Parameters and Selection

This research utilized a mixed-methods approach, using semi-structured interviews and surveys to understand the factors that influence the role of monitoring data by rancher-led collaboratives in the interior West and their value to these collaboratives.

Rancher-led collaboratives selected for this study fit three criteria: (1) they were started by one or more ranchers, (2) they were a community-based collaborative[2], and (3) they included at least one working ranch that is actively grazing cattle on public land in the interior western US and/or includes stakeholders from a state/federal land management agency.

Through purposive and snowball sampling techniques (Biernacki and Waldorf, 1981; Patton, 2002), 24 rancher-led collaboratives were identified (Appendix 1) that met these parameters

[2] summarized definition from the Community-Based Collaboratives Research Consortium: a group that has been convened voluntarily from within the local community to focus on a resource management issue(s) involving public lands; brought together by a shared desire to influence the protection and use of natural resources through recommendations or direct actions that will impact the management of the resource; utilizes a decision-making process that requires participation by local stakeholders (Moote et al. 2000)

through internet searches, suggestions from researchers familiar with rangeland management, and recommendations from respondents. All 24 rancher-led collaboratives were contacted with a request to participate in this study. As this study focused on rancher-led collaboratives, it does not represent the ranching community in its entirety, since not all ranchers belong to collaboratives (McKinney and Field, 2008).

A total of 19 interviews were conducted, representing 20 rancher-led collaboratives, and including 21 respondents (Table 3). Nineteen surveys were completed as one collaborative did not respond to the survey request.

Respondent	Interview	RLC representing	Respondent Background	Respondent – Male/Female	Respondent – Age Range
1	I – 1	C – A	Rancher	Female	20 – 40
2	I – 2	C – B	Scientist/Rancher	Male	20 – 40
3	I – 3	C – C	Scientist/Rancher	Male	20 – 40
4	I – 4	C – D	Rancher	Female	40 – 60
5	I – 5	C – E	Scientist	Male	40 – 60
6	I – 6	C – F	Rancher	Male	40 – 60
7	I – 7	C – G	Rancher/Scientist	Female	20 – 40
8	I – 8	C – H	Rancher/Scientist	Male	20 – 40
9	I – 9	C – I	Rancher	Male	60 +
10	I – 10	C – J C – S	Rancher/Scientist	Female	20 – 40
11	I – 11	C – R	Scientist	Female	20 – 40
12	I – 12	C – K	Scientist	Male	20 – 40
13		C – K	Scientist	Female	20 – 40
14	I – 13	C – L	Rancher	Male	20 – 40
15	I – 14	C – L	Scientist	Female	20 – 40
16	I – 15	C – M	Scientist	Male	20 – 40
17	I – 16	C – N C – T	Rancher	Female	40 – 60
18	I – 17	C – O	Rancher	Female	60 +
19		C – O	Scientist	Female	20 – 40
20	I – 18	C – P	Scientist	Female	20 – 40
21	I – 19	C – Q	Rancher/Scientist	Male	60 +

Table 3. Interview Information including respondent attributes (Note: RLC – rancher-led collaborative)

Interviews

Semi-structured interviews were conducted between June and August 2021. Each collaborative was asked to provide 1-2 individuals, hereafter referred to as "respondents", with the most in depth knowledge about each rancher-led collaborative and their monitoring efforts. Each interview lasted between 1-2 hours, all interviews but one were conducted and recorded over zoom; the remaining interview was conducted in person but recorded through zoom. The recordings were automatically transcribed using the zoom cloud software. All transcripts were de-identified for anonymity and the identifiers were stored on a secure drive, per IRB rules, and then imported in to MAXQDA 2022 software (VERBI Software, 2021) for analysis. These measures were in accordance with IRB approval (IRB project number 1721984-2).

Surveys

In order to answer the second research question, each collaborative was requested to fill out a survey in the form of a spreadsheet about their monitoring variable categories along with some collaborative attributes provided through email. For the monitoring variable category spreadsheet, collaboratives were asked to provide the following information: (i) name of monitoring variable or category (ii) type of data (social, ecological, economic), (iii) what data is being collected for that variable or category, (iv) is it collected on public land, private land, both, or n/a, (v) how often is the data collected, (vi) who collects this data, (vii) who analyzes the data, (viii) what is the data used for, (ix) who owns/manages the data from this variable or category, (x) are you required to collect this data? If so, by whom?

Some collaboratives offered existing materials that contained this information. In those cases, I examined those materials and entered the information in the spreadsheet myself based on those documents.

Interview Analysis

Interviews were recorded, transcribed, and analyzed using MAXQDA, a qualitative analysis tool, to code trends determined based on previous research, and later trends that emerged from the interviews (Corbin and Strauss, 2008; Wurtzebach, 2018). This analysis process is guided by grounded theory, originally developed by Glaser and Strauss (1967) and Strauss and Corbin (1990), which attempts to uncover current trends while also understanding how the study subjects respond to changes in those trends and the effects of their actions. (Corbin and Strauss, 1990).

As each interview was conducted notes were taken on key trends. Inductive coding, a form of coding where you allow your understanding to emerge from the text (Bernard, 2006), and in vivo coding, using actual phrases in the interviews to create a code (Corbin and Strauss, 1990) were used. The researchers background in rangeland management, collaborative conservation, and ecological & socio-economic monitoring helped to identify some initial themes and additional themes were identified that emerged from the data (Bernard, 2006). The first five interviews were initially coded while the rest of the interviews were being conducted to inform the remaining interviews. If a new key trend or finding came through that information it was used to inform subsequent interviews (Corbin and Strauss, 1990). All interviews were then coded, including re-coding of the five initial interviews, as part of the iterative process of grounded theory (Corbin and Strauss, 2008). In order to start to categorize the trends further, a

second round of coding was used where subcodes were added to each main trend in order to further find the similarities and differences amongst the interviews.

This study does not attempt to evaluate the ecological improvements from these rancher-led collaboratives and thus no conclusions are drawn about which collaboratives monitoring or outcomes are better than another. While every attempt was made to capture all responses from respondents in the coding and analysis, it is possible that a respondent's response was missed or misinterpreted and thus any information in the results should not be taken as saying other respondents would not agree with a statement but rather that it was not apparent in their semi-structured interview.

Survey Analysis

The analysis on the monitoring variable spreadsheets provided by the collaboratives were utilized to answer the second research question, for the rancher-led collaboratives that are carrying out monitoring, what variables and corresponding data are they collecting? The entries were placed into three basic categories, economic, social, and ecological to provide consistency across the monitoring variables and enable statistical analysis (Table 4). Due to limitations in sample size, only three categories were used and analysis was not conducted on more specific categories such as those under the ecological category like habitat improvement. These categories were determined after review of all the entries submitted by collaboratives, and intercoder reliability (Bernard, 2006), also referred to as double-blind coding, was used to reach agreement on these categories best representing the variables submitted.

Category	Examples of what's included
Economic	Forage Availability/Production for Livestock, Funding/Support
Social	Community/Education, Justice, Diversity, Equity, and Inclusion, Participation/ Volunteers, Reach/Impact
Ecological	Carbon, Precipitation, Stream Flow, Land Stewardship, Number of Acres Conserved/Protected, Easement Monitoring, Vegetation, Riparian, Wildlife, Wildfire Management, Acres Enhanced, Miles of Fence Removed, Invasive Species Management, Prescribed Burn Acres, Birds, Fish, Large Mammals, Small Mammals, Carcass Removal or #, Predator Population

Table 4. Monitoring variable categories. Monitoring variables were grouped into three classifications, including economic, social, and ecological. Examples of the original monitoring metrics corresponding to each category are provided.

The data were analyzed in RStudio (R Version 4.0.4). The response data were treated as a binomial 'yes' and 'no' response against various predictors used to answer the questions above. Since these are categorical data, the data were analyzed using generalized linear models with a binomial error distribution. Data were considered significant if the p-value was below 0.05.

RESULTS

Respondent & Collaborative Attributes

The key attributes of the 21 respondents are shown in Table 3. Though each respondent was self-selected by each rancher-led collaborative, there was a fairly even split between those that came from a ranching background (7), a science background (8), and those that came from a ranching and science background (6). It has been noted that the opinions of these two groups are often at odds and do not always line up, particularly in regard to ranch management (Sheridan, 2007) and thus while it was not done intentionally (as participants were self-selected as those with the most knowledge about each collaborative), this balanced sample of ranchers and individuals with a science background reduces potential bias in respondents.

Most collaboratives were place-based, meaning they are focused on environmental and ranch management issues as they pertain to a specific place or region, with the exception of two

collaboratives that were interest-based and state-wide. These two collaboratives have at least one partner/stakeholder that participated in this study as a place-based collaborative. It is not uncommon for a place-based collaborative to participate in a larger interest-based and/or state-wide collaborative, as there are different scales of collaboratives that are appropriate depending on the purpose. Additionally, one placed-based collaborative (C-T) contained two smaller place-based collaboratives (C-L, C-N). Though the interest-based collaboratives were treated as independent in this study, it is possible that those place-based collaboratives that participate in the interest-based collaboratives and the interest-based collaboratives could influence one another's thoughts on monitoring.

Each collaborative was asked to provide their landownership breakdown by the following categories, federal, state, private, tribal, and other. The two interest-based/state-wide collaboratives, C-R and C-S, serve a state-wide interest and thus they were not asked to provide their landownership breakdown because it would simply include the entire acreage of a state. Additionally, C-H, C-J, and C-O chose to not provide their landownership breakdown. Of the 15 collaboratives that did provide their landownership breakdown, eight were majority public land (federal and state) and seven were majority private land. Majority landownership was determined by the landownership that was over 50% of the total area served.

During the interviews a number of reasons were brought up as to why these collaboratives started. Threat of species listing, threat of NGO or agency tension, and fragmentation/development were mentioned multiple times, while a lack of communication and maintaining rural livelihoods were mentioned once each. Additionally, 12 respondents said focusing on common ground has led or leads many groups to working together and collaborating.

Why monitor? Data Drivers and Data Use

To answer in part the first research question, why rancher-led collaboratives monitor, information was pulled from the interviews about data drivers and data use mentioned by the respondents. Four rancher-led collaboratives reported that they do not monitor. Respondents from these four rancher-led collaboratives mentioned a few specific reasons including (1) ranchers wanting to stay separate in terms of monitoring due to risks associated and the effort that comes with collecting data together, (2) not having funding for the overall collaborative work and thus would need to solve the issue of funding for their collaborative before dedicating funding to monitoring, (3) seeing their role as a facilitator of monitoring opportunities across the community rather than collecting the data themselves (mentioned by one of the interest-based state-wide collaboratives), (4) or are currently working on setting up monitoring but have not yet begun.

Responding to required monitoring for grants and agencies was the most frequent reason for monitoring though many other reasons were mentioned (Table 5). Drivers explore the original reasons behind the decision to collect data. Respondents mentioned three additional data drivers: informal observation from rancher that leads to monitoring, collaboratives recognition of benefit and need for data, or partner driven. Respondents also disclosed how they use the data they have collected (Table 5). In most cases, at least some of the data drivers mentioned by a collaborative match up with their subsequent uses of data.

	Responding to required monitoring for grants or agencies	Monitor a project/program or management practice	Communication tool or back up past decisions	Identify knowledge gaps or issue to address
Data Drivers	8	4	7	7
Data Use	6	7	11	5

Table 5. Data Drivers and Data Use – Mentions during interviews of data drivers and data use by rancher-led collaboratives to monitor

Interview Trends

To answer the third research question on the value and utilization of monitoring data for rancher-led collaboratives and provide additional context to the first research question on why they collect data, specific trends emerged from the interviews on the role and value of monitoring, as well as the barriers, challenges, and opportunities. These trends are presented here to highlight the findings where there was consensus amongst multiple respondents and collaboratives as well as nuances and disagreement when relevant.

Overall, this study resulted in three important trends for rancher-led collaboration: 1) monitoring data is needed over the long-term but is hard to fund, and a mix of longer-term data along with shorter-term data that can be used for adaptive management would be ideal, 2) informal monitoring and monitoring at different scales are a necessary complement to formal monitoring, and 3) ranchers are interested in science and data but find it hard to form trusting relationships, a challenge that collaboratives help overcome (Table 6). All in all, there was recognition from the respondents that their collaboratives are able to do more in terms of monitoring and science when working together with multiple partners. One respondent remarked, *"if we're doing something in our backyard and it's in their front yard, we should all know what we're doing and how we can optimize [that work]" (3, C-C).*

Interview Trends Summary	
Trend	Example Quotes
Trend #1: There is value in both long-term (nine respondents, including one representing an interest-based collaborative) and short-term monitoring (15 respondents, including one representing an interest-based collaborative), but a lack of capacity to monitor (11 respondents, including two representing interest-based collaboratives).	"You know [monitoring data has] made us infinitely better about knowing even what questions to ask." (1, C-A) "If you go look at a project after it's done a year later, you might be able to start getting some data but ultimately three, four or five years later is when you actually start seeing the results of your projects." (3, C-C)

	"The problem is agencies don't have the time to go out more often, so they are making the decision on your permit based on one data collection, which could be a particularly bad day." (10, C-S)
Trend #2: Due to limitations in formal monitoring, there is value in informal observations (seven respondents, including one representing an interest-based collaborative) and different scales of monitoring (14 respondents, including one representing an interest-based collaborative).	"Maybe [the] landowner has an important observation or it's a recurring theme and I try to catalog those in my mind." (8, C-H) "How are you going to collect data from multiple states where everything has to be done differently. I think you're making it harder by doing that, but it's also really cool to see it from that big state level." (20, C-P)
Trend #3: Collaboration helps ranchers build the trust necessary to collaboratively monitor or share data (15 respondents, including one representing an interest-based collaborative).	"The time that we spend working with agency folks having conversations just affects the tone of the valley. It affects how agency folks approach [ranchers], it affects how we approach agency folks and it affects how other researchers come out here." (1, C-A) "I kind of become a middleman between rancher's interests and an agency's interests and try to help understand what the other one needs." (16, C-M)

Table 6. Interview Trends – Overview of the main trends from the interviews

Trend #1: There is value in both long-term and short-term monitoring but a lack of capacity to monitor

Decision-making is complex for these rancher-led collaboratives and there is a need for monitoring and data to make better informed decisions, with an interest in more flexibility and adaptability to do so. For two collaboratives, including one interest-based, this means working on new or more simplified tools for monitoring with the intention to also help agencies with required data collection so the data can be more easily used to make decisions. Federal agency monitoring, as felt by one respondent, is often just monitoring to monitor: *"At least my experience with federal agency monitoring is it's just monitoring, for the sake of monitoring. It doesn't really inform any decision making." (14, C-L)*

More flexibility and adaptability in regards to monitoring was of interest for eight respondents, including one that represents an interest-based collaborative, in order to use data collected to make better informed decisions, both for rancher's permits on public land and the collaboratives themselves: *"Flexibility of just being able to do what we need to do so that we can make good decisions for the land." (16, C-M) (See Table 8 for additional examples)* One rancher-led collaborative, who is working with federal agencies on their monitoring plan, is hoping to provide a good example of how adaptability and flexibility can be possible when it comes to required monitoring on public land allotments.

Nine respondents, including one that represents an interested-based collaborative, found that in order to make those better decisions data trends are needed to make decisions based on the data, understand what is happening on the landscape over time, and see if the intended outcomes from the collaborative's efforts are being achieved. However, one respondent noted that *"it's a challenge to combine older data with new data, in terms of the techniques that were used" (9, C-I). (See Table 9 for additional examples)* Thus, collaboratives that have a consistent long-term data set are able to look at those trends more easily, which was not found for all collaboratives in this study.

While many respondents discussed the value in data trends for their collaborative, which generally falls under long-term monitoring (data collection over a period of time), four respondents also noted the value in short-term monitoring that can be used to make decisions for a project or a more immediate management action. However, five respondents expressed that the pace of monitoring, whether short-term or long-term, was too slow to truly be used in decision-making. And one respondent added that "*the pace [of data] is too slow for ranchers to make management decisions quickly, but [once analyzed] it [does] support decisions made in the*

past." (9, C-I) (See Table 10 for additional examples) It is clear that the timing and frequency of data collection play a role in its usage by a rancher-led collaborative.

However, 11 collaboratives, including two interest-based collaboratives, experience issues of lack of capacity and support which affects their ability to monitor, both in data collection and analysis, and to sustain that monitoring. One respondent noted, *"we don't have the capacity right now to be able to continue to do the monitoring." (3, C-C)* This lack of capacity can be within the rancher-led collaboratives themselves to do monitoring they are required and/or interested in conducting as well as for the agencies they work with, mentioned specifically by five respondents. *(See Table 11 for additional examples)* Further, three collaboratives, including one interest-based collaborative, have found it difficult to get funding specifically for monitoring. One respondent explained: *"[Monitoring] is really unsexy [to funders], but everyone needs it." (18, C-O)* Because of this barrier, six rancher-led collaboratives are receiving or have received support for monitoring from either an NGO or research entity, making them invaluable partners. While there were a number of issues related to a lack of capacity and support, one respondent provided an option for the future of their collaborative: the use of remote sensing data which when done at a bigger scale becomes less expensive.

Trend #2: Due to limitations in formal monitoring, there is value in informal observations and different scales of monitoring

Depending on the question a collaborative is trying to answer, informal observations can be an important complement to formal monitoring. For truly quick decisions, such as those that are day-to-day or even season-to-season on a ranch, one rancher-led collaborative uses more informal results. In fact, one respondent reported that their collaborative will informally share information back to whoever asked the question, which might be a rancher, because of the delay

in results from their monitoring. Another respondent mentioned that the impacts of climate change mean that there is no time to wait for academic studies to come out; it is necessary to make decisions rapidly: *"We kind of know what's happening and we need to improve things on the ground as fast as possible." (12, C-K)*

In addition to informally sharing results due to the speed of monitoring, observations from ranchers were mentioned as being used by six collaboratives, wherein ranchers will tell the collaborative what is happening on their lands. This can result in rancher-led collaboratives using that information to inform a new effort or to support current projects*: "Maybe [the] landowner has a really needed observation or it's a recurring theme and I try to catalog those in my mind." (8, C-H) (See Table 13 for additional examples)*

Because these collaboratives often only have the ability to do formal monitoring a collaboratives area served and specific projects, eight respondents explained that their rancher-led collaboratives are often unable to see what is happening on a larger scale due to the challenges of combining data from different sources and landownerships. Three rancher-led collaboratives are currently working on extrapolating their local-scale data or combining it with other datasets with the help of partners to see what is happening beyond their landscape. For one of these collaboratives, they have dealt with this challenge by giving their data to an agency to do the actual analysis and data assimilation. But for a variety of reasons the other five rancher-led collaboratives that are interested in seeing what happens beyond their landscape do not have plans to try to do so with their own data. One respondent noted, *"how are you going to collect data from multiple states where everything has to be done differently. I think you're making it harder by doing that, but it's also really cool to see it from that big state level." (20, C-P) (See table 12 for additional examples)*

When thinking about larger scale data, four respondents noted the need to think about remote sensing in combination with on-the-ground data, particularly because they feel remote sensing is a good tool but that there is still a need to provide ground-truthing to remote sensing data. Additionally, three respondents felt that there are different data needed depending on the scale of the question you are trying to answer. One respondent did point out that due to the variability of rangelands it might be hard to extrapolate or combine data because it might be very specific to a particular ranch or pasture. This raises the question of what the right scale is for data and whether collaboratives can collect data that is at a larger scale to tell them more about their area served. One respondent explained, *"it would be really cool to be able to say, we got some techniques that allow us to effectively monitor at that scale, and the answer is we don't and no one that I've spoken to does. And this has been an ongoing topic for a decade plus." (6, C-F)*

Trend #3: Collaboration helps ranchers build the trust necessary to collaboratively monitor or share data

For nine collaboratives, including one that is interest-based, trust is important to be able to do shared monitoring together and to share data with partners, but building that trust takes time and is often challenged by turnover in agency partners. One respondent explained, *"we have really good agency folks overall but I think a lot of it is just learning and building those relationships. So once they turn over you have to start over." (4, C-D) (See Table 14 for additional examples)* While some rancher-led collaboratives have built that trust, eight respondents, including one that is part of an interest-based collaborative, still felt that a lack of trust is a barrier to data sharing. One respondent, from an interest-based collaborative that works on a larger scale and has less on-the-ground ecological data points to show based on their collaborative's purpose, explained that while trust is extremely important to collaboration, it is

hard to quantify and thus it is hard to provide the evidence to funders for the time needed to grow that trust. In addition to the trust required to share data, collecting data on the landscape together was felt by one respondent to help build trust among ranchers and agencies or researchers by spending time together out on the land. However, no matter how much trust is built, two respondents made it clear that they see it unlikely that any amount of trust will allow for data sharing at the level of ranching operations due to privacy issues.

With the trust built in these rancher-led collaboratives, nine respondents felt that their collaborative served as middlemen by facilitating relationships between ranchers and researchers or agencies. Although these researchers and agencies provide additional data and monitoring for rangeland management, it is often challenging for them to reach out to ranchers directly due to a lack of trust. Rancher-led collaboratives provide a conduit for these two groups to work together to the benefit of both sides*: "I kind of become a middleman between rancher's interests and an agency's interests and try to help understand what the other one needs." (16, C-M) (See Table 15 for additional examples)* Additionally, three collaboratives provide their own guidance on monitoring to landowners because ranchers trust them and know they have the necessary knowledge. One respondent explained that *"[it's] not about telling ranches what they should be doing, it's more about giving information, engaging people, and giving them opportunities to choose to participate." (1, C-A)*

Even if trust has been built, the different landownerships that are part of these rancher-led collaboratives, such as federal, state, and private land, have different issues, needs, and priorities, which has made it a challenge for eight collaboratives, including one interest-based, to share or combine data and monitor across them: *"It is amazing how different the big pressing issues can be depending on the land ownerships." (1, C-A) (See Table 16 for additional examples)* Even

with the challenges of working across different landownerships, four rancher-led collaboratives that noted this challenge are interested or currently trying to combine public and private data, and *"blur boundaries in many cases" (5, C-E)* because they see the value of being able to see a full picture of their work.

With agencies in particular, one respondent noted it is a challenge to combine their data with an agency because of the high rates of turnover which affect their ability to manage or even find the data that the agency has collected. Two respondents, including one interest-based, also added that agencies are often not able to use data collected by a collaborative or ranchers because of regulations or not wanting to show favoritism.

Monitoring Variable Categories

Of the monitoring variable categories, ecological, social, and economic, ecological monitoring data was the most frequently collected by the collaboratives while economic monitoring data was collected the least (Table 7). While collaboratives were most frequently part of the data collection for social and economic monitoring data and second most frequent for ecological monitoring data (Table 7), there was no significant relationship between whether the rancher-led collaborative was itself involved in the data collection and the type of monitoring category (economic: $\chi^2 = 0.52$, $p = 0.47$; social: $\chi^2 = 0.07$, $p = 0.78$; ecological: $\chi^2 = 0.07$, $p = 0.78$).

However, agencies, that are most frequently involved in collecting ecological monitoring data, were found to have a significant relationship between an agency and their involvement in the data collection for ecological monitoring ($\chi^2 = 11.30$, $p = 0.0007$; 69% probability that an agency would be involved). Additionally, for social monitoring, there was a significant

relationship found between an agency and their lack of involvement in collecting social monitoring data ($\chi^2 = 6.62$, $p = 0.01$; 65% probability that an agency would not be involved).

Ecological					Social			Economic		
Collaborative	Agency	Partner	Rancher	Contractor	Collaborative	Agency	Partner	Collaborative	Agency	Partner
	X			X						
	X	X					X			
X	X	X					X	X	X	
X	X	X			X	X				
X		X			X		X			
X	X	X					X	X		
X								X		
X	X	X	X		X	X				
					X		X	X		X
					X					
X	X			X	X			X		
	X	X		X		X	X		X	X
X	X		X	X		X				
X	X	X			X					
	X				X					
9/13	11/13	8/13	2/13	4/13	8/11	4/11	6/11	5/6	2/6	2/6

Table 7. Data Collection Participants by Stakeholder Group (Note: Rancher and Contractor are not included in social and economic data collection columns because they do not participate in any data collection for those categories)

DISCUSSION

Why monitor?

All respondents in this study saw value in monitoring, even those not currently monitoring, though they differed in their reasons and level of monitoring they felt was helpful. Prior to this study, although there was evidence that at least some groups were actively engaged in monitoring (Fernandez-Gimenez and Ballard, 2011), there was limited information on what monitoring data are being collected by rancher-led collaboratives, and in fact by broader community-based collaboratives across the U.S. This study shows that 16 out of 20 collaboratives are currently using monitoring data, either collected by the collaborative themselves or with help from partners. This is not surprising as there is an interest among ranchers in being able to show to the public that they care about the environment and that

ranching does not have to be detrimental to the environment (Brunson and Huntsinger, 2008; Didier and Brunson, 2004; Wilmer et al., 2018). However, it is important to note that in this study, the ranchers that have chosen to be a part of these collaboratives may, in particular, have an interest in the science and data and thus it is hard to say if the findings in this study are true of other ranchers in the west. Additionally, the rancher-led collaboratives that were invited to participate but did not respond may have done so because they don't monitor or believe that monitoring could be valuable.

There was a feeling amongst the respondents that it would be useful to be able to show the value in collaboration and the collaborative process, which is part of the social monitoring category. Many respondents mentioned interest in collecting data to show increased trust, reduced conflict, and better consensus in decisions to illustrate the benefit of collaboration and the value of engaging local landowners in the management of the land, particularly with more quantitative metrics data points. However, while 15 collaboratives were collecting actual ecological data that has the ability to show them the changes on the landscape, only one of 11 collaboratives collecting social data was truly trying to quantify the benefit of collaboration and the improvements for the people on the landscape through social indicators. Most of the social monitoring in this study was found to focus on the number of people engaged (such as through volunteerism) and organizational reach and impact (such as email lists, meeting attendees, etc.), lacking the ability to show the success of collaboration. Those types of metrics were most often collected and used to report back to funders on their engagement and as a communications tool with the public. Yaffee & Wondolleck (2003) found this to be true in their work, that even though community-based collaborations more generally aim to find credible ways to show their success and value of collaboration they struggle to find the right tools to do so. Additionally,

agency partners are unlikely to help in this type of monitoring as were they found to have a significant relationship in not participating in social data collection. This lack of participation in social monitoring may be due to the training of many agency employees, across both the Forest Service and Bureau of Land Management, focused on rangeland and forest science (Koontz & Bodine, 2008). The evaluation and integration of social and economic information sources is a part of both agencies' ecosystem management/land management planning approaches but due to this disconnect in the majority of their work force it is challenging to implement (Koontz & Bodine, 2008). The Forest Service has been working to include more social scientists, which researchers have noted since the early 2000s, though they still make up small portion of the workforce (Brown & Harris, 2000; Koontz, 2007; Koontz & Bodine, 2008).

Rancher-led collaboratives that struggle to provide proof of the social value of collaboration may consider tools such as the Partnership Impact Model™ that seeks to help collaboratives show the added value and impact of working together through measurable indicators (Goldberg and Mickel, 2018; Mickel and Goldberg, 2019). The Partnership Impact Model™ could not only provide this proof on the value of collaborating as a management tool but also show the collaborative where they may need to improve and gain a better understanding of how their partners perceive and feel about their work.

A recognized need for monitoring, both long-term and short-term, but a lack of capacity to do so.

Many rancher-led collaboratives noted that monitoring and data are needed in order to make better decisions and to know what questions to ask, but such use is not currently occurring for the majority in this study. Often monitoring programs are unsuccessful because they are not collecting the information needed to meet their objectives (Biber, 2013), which is echoed in this study where many collaboratives collect data because they are required to collect it for a grant or

agency and not to meet their objectives. To be able to inform management decisions, rancher-led collaboratives will need to think more deliberately about their monitoring plan and include variables that respond to the management actions and are collected long enough to detect change (Bestelmeyer et al., 2019).

Rangelands, and more generally the environment, can be slow to change and longer data collection is needed to see the response (Bestelmeyer et al., 2019; Biber, 2013; Lovett et al., 2007). However, while rancher-led collaboratives understand the need for long-term monitoring, it tends to be a challenge for many due to a lack of funding for both the collaborative and agencies and the difficulty of combining older data with new data. While long-term monitoring is needed to describe the changes occurring, this information is often too slow to inform more immediate management decisions or short-term projects. It does however provide important context for short-term needs (Lovett et al., 2007) and, if utilized correctly, interim data from long-term monitoring has the opportunity to be used to adjust and adapt in more real-time, the goal of adaptive management. This perhaps provides a way for collaboratives to have short-term and long-term data through one monitoring plan which could decrease the cost by collecting less data overall.

Adaptive management is an approach that allows a group to engage in creating an informed management plan with available data and identifying and collecting data to help them understand if the goal and outcomes of the management plan are being achieved, while building adaptive capacity (Folke et al., 2003; Muñoz-Erickson et al., 2007; Olsson et al., 2004; Gunderson, 2003). Collaborative adaptive management occurs when rancher-led collaboratives use monitoring data to make decisions or to determine whether their projects and programs are working together. While some of the rancher-led collaboratives are using this approach few

explicitly describe it as adaptive management. For rancher-led collaboratives that are not currently collecting and using data in this manner, there is an opportunity for them to do so more directly. However, it is important to note that while community-based collaboratives in general have been found to use adaptive management, there is often a lack of follow-through in applying the results from the monitoring efforts to future management decisions (Fernandez-Gimenez and Ballard, 2011).

One reason for this lack of follow through, noted by a number of respondents, goes back to a lack of capacity, an issue that must be solved or rancher-led collaboratives are unlikely to experience better outcomes as they suffer from capacity issues similar to other community-based collaboratives. This is perhaps the greatest barrier to monitoring for rancher-led collaboratives, both in terms of personnel and access to funding. Respondents reported that monitoring funding was difficult to obtain, consistent with other studies that have found that monitoring is not only costly but often underfunded (Byron and Curtis, 2002; Fernandez-Gimenez and Ballard, 2011; Whitelaw et al., 2003). The high cost can be a barrier to managers wanting to commit to monitoring efforts (West, 2003; Wright et al., 2002), but a better understanding of the benefits from such data could show the value of monitoring for both a hesitant collaborative and funders. To help with the issues of capacity and support, six collaboratives in this study reported that they had received support from a partner in order to do monitoring when unable to initially fund and sustain long-term monitoring (Bestelmeyer et al., 2019), which shows the value of these collaboratives and why they put high importance on the partners involved in their work.

A need for informal observations and different monitoring for larger scales as a complement to the limitations of formal monitoring.

While the speed of monitoring and research is often considered too slow for many of the rancher-led collaboratives to use in making decisions, they still provided value in backing up decisions made by ranchers and the collaborative once those data were analyzed. There is, however, important value in more informal monitoring in the form of ranchers' observations, which can often be used in the interim while waiting for the results of formal monitoring. The knowledge these ranchers have about their ranches and allotments can be a complement to scientific information (Knapp and Fernandez-Gimenez, 2009). In fact, ranchers' observations and informal assessments of the land can be used to identify a concern or issue that these collaboratives can then formally monitor even if it not currently part of their normal data collection (Woods and Ruyle, 2015). This could be particularly useful for these collaboratives that struggle with funding to have more robust and comprehensive monitoring as it is an opportunity to use those already on the ground to capture something that would be missed otherwise. It is hard to imagine some of these larger collaboratives ever attempting to collect monitoring data across their entire area served and thus there is likely always to be a reason to incorporate ranchers' observations. Additionally, given how variable rangelands are (West, 2003), the use of more frequent informal monitoring, through ranchers' observations, in addition to formal monitoring could enable more rapid detection of change and may be necessary to make adaptive management possible for these collaboratives (Woods and Ruyle, 2015).

Due to the high variability of rangelands (West, 2003) some data is also very specific to one ranch or collaborative group and thus it is not inherently easy to "scale it up" to explain the surrounding landscape. This challenge of scale might be best solved by matching the indicator to the intended scale (Armitage et al., 2009; Boyd and Charles, 2006). Though not appropriate to scale up data collected at a local level to draw conclusions about a larger landscape, there is

opportunity for rancher-led collaboratives to continue to improve their more local formal monitoring efforts and partner with other collaboratives, researchers, or NGOs to collect other indicators meant for a larger scale. It is important that these local collaboratives continue to do formal monitoring at the local level because monitoring set up by outside scientists has been found to be more useful at a larger scale and often lacks the intended local impact (Danielsen et al., 2010). This also helps collaboratives communicate how they are part of a larger system as they search for more funding and support.

A need for trust to collect and share data with others.

Lastly, it cannot be overstated how important trust is in order to inspire data sharing or to convince ranchers, land managers, and researchers to work together. Since almost all rancher-led collaboratives include some amount of public land, it is imperative that they work with federal and state agencies who manage the public lands they rely on. However, agencies are largely driven by a bureaucratic management approach, which differs greatly from collaborative processes (Yaffee and Wondolleck, 2003) that seek to ask questions as a group of stakeholders. Collaborative processes that engage scientists, land managers and local stakeholders increase trust and communication (Armitage et al., 2009) and has allowed collaboratives to do monitoring that has greater longevity than these partners working alone (Muñoz-Erickson et al., 2010). This longevity is also important due to the high turnover within state and federal agencies that can derail trust built between a land manager and a rancher. The benefit of collaboration when trust is present has been found to increase the communication between ranchers and scientists leading to better, more sustainable outcomes (Knapp and Fernandez-Gimenez, 2009).

There is also an interesting reciprocity between the importance of trust to inspire data sharing and monitoring as a collaborative and the dynamic explained by one respondent that

collecting data together on the landscape actually helps to build that trust through time spent learning and engaging with one another. Both McKinney and Field (2008) and Straube (2017) also note that collecting information together out on the local landscape can help to build trust and overcome differences in monitoring protocols that could help to create a more unified monitoring plan, a goal for many of the rancher-led collaboratives in this study.

IMPLICATIONS

The role and value of monitoring can be complex and context-dependent. While monitoring is necessary to understand the changes on a landscape over time and whether projects and programs are having their intended impact, it is a challenge to set up a successful monitoring plan due to many factors including time, cost, personnel, and choosing the correct variables in a complex landscape such as rangelands. It is clear from the results of this study and other literature in the field that there is often a push and pull of wanting monitoring data to be in "real-time" and recognizing that, particularly on rangelands, time is needed to understand how the landscape is changing. Rancher-led collaboratives have the opportunity to serve an important role in monitoring, data, and science due to their longevity on the landscape and trust built that more easily gets ranchers on board and creates lasting partnerships. They are and can continue to be a conduit to ranchers for researchers and agencies to create more collaborative monitoring plans and improve data sharing and data collection. This allows for agencies to better complete their required monitoring, researchers to do more extensive projects and research, and collaboratives to identify the questions they want to answer and where monitoring and data will be the most useful.

As the west continues to be impacted by climate change, more fragmentation, and increasing political divide in how to manage the land, it will be essential to engage with these

rancher-led collaboratives. If given the right capacity and support, these rancher-led collaboratives, that not only have the trust of ranchers but of their local communities, could have huge impacts on conservation efforts across the West. Ranchers are invested in conserving the West, but if we do not include their voices at the table and empower the local communities they represent when making land management decisions, we are likely to continue to see conflict that could stall important conservation work and restoration efforts.

CHAPTER 4 - CONCLUSION

It is my hope that the results and discussion presented here can inform organizations, collaboratives, and funders to understand the current landscape of rancher-led collaboratives and their views on the value and role of monitoring. It is clear that rancher-led collaboratives see the value in monitoring data, though the role that data plays in their work differs across the collaboratives in this study. There is however a perception that ranchers don't see the value in science and data, a stereotype which is proven incorrect in this study. As a communication tool, the results presented here provide proof across 20 rancher-led collaboratives in the interior western U.S. the value they put on monitoring but also the challenges that hinder the role that monitoring currently has for these collaboratives.

LIMITATIONS

This study does have limitations as it only presents the view of individuals that participate in rancher-led collaboratives and thus does not speak to ranchers that are not part of these collaboratives as well as collaboratives that do not engage ranchers. Though certain statements made by respondents were about actions and approaches of their collaboratives, the responses about their thoughts or understandings of their collaborative can only be attributed to that specific respondent. Due to these limitations, I see this study as a first step from which the results can be turned into a survey tool to glean a greater understanding into the specific role of for these collaboratives by surveying multiple partners in each collaborative. This study could also be given to ranchers, researchers, and agencies not in collaboratives currently to determine the similarities and differences amongst those participating in a collaborative and those that are not.

RECOMMENDATIONS

In order to ensure that data collected by rancher-led collaboratives are actually analyzed and used, it is necessary to consider what data are the most useful based on the question(s) they are trying to answer. Many rancher-led collaboratives were found to collect data but not the data they needed to monitor the outcomes of their actions. One recommendation is to consider collecting a reduced amount of data in order to ensure they are actually analyzed and used. Rancher-led collaboratives, particularly those engaging the ranchers in monitoring, will need data that are simple enough for ranchers to collect, analyze, and use. Given the focus on ecological monitoring for federal land management agencies, collaboratives that seek to be better able to show their importance through social monitoring may need to do so with their own funding and monitoring tools. The Partnership Impact Model™ is one such tool that a collaborative could use to show the value of collaboration and is set up to walk them through the process (https://www.onetam.org/partnership-impact-model). It is also possible that collaboratives will receive increased support from agencies as more social scientists, with training in areas of collaboration and social processes, join the Forest Service.

There were many challenges noted specifically for data analysis and management (such as data storage) including needing to move all paper files in to an online database, not having the necessary in-house expertise to analyze the data collected, and a lack of understanding of the use of data. Additionally, due to the need for many different funding sources in order to pull together enough funding for a collaborative, these groups often struggle to have a cohesive monitoring plan as funders require different data to be collected and analyzed. For ecological monitoring, remote sensing in conjunction with ground truthing was mentioned by a number of respondents in this study as a way to improve monitoring and ensure better utilization of that data. Currently,

remote sensing is very expensive for one collaborative to do on its own but if done with multiple partners it may become more cost-effective as a way to monitor. Due to the cost and need for someone with expertise in remote sensing, rancher-led collaboratives could consider LandPKS (https://landpotential.org/), a new set of tools available through a mobile app meant to be user friendly for landowners and land managers without the need for a lot of specialized training. While LandPKS is not intended to replace more in-depth formal monitoring but rather to supplement monitoring, it is an option to collect and analyze data that, if used correctly, can directly correlate to a collaboratives management objectives.

As capacity is the overall limiting factor for rancher-led collaboratives to analyze and use data collected, funding is a crucial component. There are a number of existing funding opportunities for collaborative groups but there is limited funding that will specifically fund just monitoring or a big effort to review, compile, and manage all the data a rancher-led collaborative may hold. Given this challenge, rancher-led collaboratives should consider more intentionally including monitoring in their grant proposals that fund specific projects or staffing in order to overcome this barrier. Additionally, there are a number of regional and national organizations that work with rancher-led collaboratives who are thinking about data and may fill a positive space particularly for data analysis and management challenges. More funding that can support and sustain regular monitoring efforts could result in more collaboratives actively choosing to develop comprehensive monitoring plans that can lead to better long-term social, ecological, and economic results from their actions.

CHAPTER 5 - LITERATURE CITED

Allen, L.S., 2006. Collaboration in the Borderlands: The Malpai Borderlands Group. Rangelands 28, 17–21.

Armitage, D.R., Plummer, R., Berkes, F., Arthur, R.I., Charles, A.T., Davidson-Hunt, I.J., Diduck, A.P., Doubleday, N.C., Johnson, D.S., Marschke, M., McConney, P., Pinkerton, E.W., Wollenberg, E.K., 2009. Adaptive co-management for social–ecological complexity. Frontiers in Ecology and the Environment 7, 95–102. https://doi.org/10.1890/070089

Bernard, H.R., 2006. Research methods in anthropology: Qualitative and quantitative approaches, 4th ed. ed. Rowman & Littlefield, Lanham, MD.

Bestelmeyer, B.T., Briske, D.D., 2012. Grand Challenges for Resilience-Based Management of Rangelands. Rangeland Ecology & Management 65, 654–663. https://doi.org/10.2111/REM-D-12-00072.1

Bestelmeyer, B.T., Burkett, L., Lister, L., Brown, J., Schooley, R., 2019. Collaborative Approaches to Strengthen the Role of Science in Rangeland Conservation. Rangelands 41, 218–226. https://doi.org/doi 10.1016/j.rala.2019.08.001

Biber, E., 2013. The Challenge of Collecting and Using Environmental Monitoring Data. Ecology and Society 18.

Biernacki, P., Waldorf, D., 1981. Snowball Sampling: Problems and Techniques of Chain Referral Sampling. Sociological Methods & Research 10, 141–163. https://doi.org/10.1177/004912418101000205

Boyd, H., Charles, A., 2006. Creating community-based indicators to monitor sustainability of local fisheries. Ocean & Coastal Management 49, 237–258. https://doi.org/10.1016/j.ocecoaman.2006.03.006

Briske, D.D. (Ed.), 2017. Rangeland Systems: Processes, Management and Challenges, Springer Series on Environmental Management. Springer International Publishing, Cham.

Brunson, M.W., Huntsinger, L., 2008. Ranching as a Conservation Strategy: Can Old Ranchers Save the New West? Rangeland Ecology and Management 61, 137–147.

Byron, I., Curtis, A., 2002. Maintaining Volunteer Commitment to Local Watershed Initiatives. Environmental Management 30, 59–67. https://doi.org/10.1007/s00267-002-2552-7

Cawley, R.M., Freemuth, J., 1997. A critique of the multiple use framework in public lands decisionmaking. Western public lands and environmental politics.

Charnley, S., Sheridan, T.E., Nabhan, G.P., 2014. Stitching the West Back Together: Conservation of Working Landscapes. University of Chicago Press.

Conley, A., Moote, M.A., 2003. Evaluating Collaborative Natural Resource Management. Society & Natural Resources 16, 371–386. https://doi.org/10.1080/08941920309181

Conrad, C.T., Daoust, T., 2008. Community-Based Monitoring Frameworks: Increasing the Effectiveness of Environmental Stewardship. Environmental Management 41, 358–366. https://doi.org/10.1007/s00267-007-9042-x

Corbin, J., Strauss, A., 2008. Basics of Qualitative Research (3rd ed.): Techniques and Procedures for Developing Grounded Theory. SAGE Publications, Inc. https://doi.org/10.4135/9781452230153

Corbin, J.M., Strauss, A., 1990. Grounded theory research: Procedures, canons, and evaluative criteria. Qual Sociol 13, 3–21. https://doi.org/10.1007/BF00988593

Danielsen, F., Burgess, N.D., Jensen, P.M., Pirhofer-Walzl, K., 2010. Environmental monitoring: the scale and speed of implementation varies according to the degree of peoples

involvement. Journal of Applied Ecology 47, 1166–1168. https://doi.org/10.1111/j.1365-2664.2010.01874.x
Didier, E.A., Brunson, M.W., 2004. Adoption of range management innovations by Utah ranchers. Journal of Range Management 57, 330–336. https://doi.org/10.2111/1551-5028(2004)057[0330:AORMIB]2.0.CO;2
Fernandez-Gimenez, M., McClaran, S.J., Ruyle, G., 2005. Arizona Permittee and Land Management Agency Employee Attitudes Toward Rangeland Monitoring by Permittees. Rangeland Ecology & Management 58, 344–351.
Fernandez-Gimenez, M.E., Ballard, H.L., 2011. How CBCs learn: Ecological monitoring and adaptive management, in: Community Based Collaboratives: Bridging Socioecological Research and Practice. University of Virginia Press.
Folke, C., Colding, J., Berkes, F., 2003. Synthesis: building resilience and adaptive capacity in social-ecological systems.
Gay, C.W., 1989. Social and political constraints to adequate rangeland inventory and monitoring. Proceedings, International Conference and Workshop, Global Natural Resource Monitoring and Assessments.
Gentner, B.J., Tanaka, J.A., 2002. Classifying federal public land grazing permittees. Journal of Range Management 55, 2–11.
Goldberg, L., Mickel, A., 2018. Generating, Scaling Up, and Sustaining Partnership Impact: One Tam's First Four Year.
Gosnell, H., Travis, W., 2005. Ranchland Ownership Dynamics in the Rocky Mountain West. Rangeland Ecology & Management 58, 191–198.
Havstad, K., Peters, D., Allen-Diaz, B., Bartoiome, J., Bestelmeyer, B., Briske, D., Brown, J., Brunson, M., Herrick, J., Huntsinger, L., Johnson, P., Joyce, L., Pieper, R., Svejcar, T., Yao, J., 2009. The Western United States Rangelands: A Major Resource. Grassland quietness and strength for a new American agriculture 75–93. https://doi.org/10.2134/2009.grassland.c5
Havstad, K.M., Peters, D.P.C., Skaggs, R., Brown, J., Bestelmeyer, B., Fredrickson, E., Herrick, J., Wright, J., 2007. Ecological services to and from rangelands of the United States. Ecological Economics, Special Section - Ecosystem Services and Agriculture 64, 261–268. https://doi.org/10.1016/j.ecolecon.2007.08.005
Kenney, D.S., 200AD. Arguing About Consensus: Examining the Case Against Western Watershed Initiatives and Other Collaborative Groups Active in Natural Resources Management.
Knapp, C.N., Fernandez-Gimenez, M.E., 2009. Knowledge in Practice: Documenting Rancher Local Knowledge in Northwest Colorado. Rangeland Ecology & Management 62, 500–509.
Koontz, T.M., Thomas, C.W., 2006. What Do We Know and Need to Know about the Environmental Outcomes of Collaborative Management? Public Administration Review 66, 111–121. https://doi.org/10.1111/j.1540-6210.2006.00671.x
Lovett, G.M., Burns, D.A., Driscoll, C.T., Jenkins, J.C., Mitchell, M.J., Rustad, L., Shanley, J.B., Likens, G.E., Haeuber, R., 2007. Who Needs Environmental Monitoring? Frontiers in Ecology and the Environment 5, 253–260.
McKinney, M., Field, P., 2008. Evaluating Community-Based Collaboration on Federal Lands and Resources. Society & Natural Resources 21, 419–429. https://doi.org/10.1080/08941920701744215

Merrill, K.R., 2002. Public Lands and Political Meaning: Ranchers, the Government, and the Property between Them.
Mickel, A., Goldberg, L., 2019. Partnership Impact Evaluation Guide.
Muñoz-Erickson, T.A., Aguilar-González, B., Loeser, M.R.R., Sisk, T.D., 2010. A Framework to Evaluate Ecological and Social Outcomes of Collaborative Management: Lessons from Implementation with a Northern Arizona Collaborative Group. Environmental Management 45, 132–144. https://doi.org/10.1007/s00267-009-9400-y
Muñoz-Erickson, T.A., Aguilar-González, B., Sisk, T.D., 2007. Linking Ecosystem Health Indicators and Collaborative Management: a Systematic Framework to Evaluate Ecological and Social Outcomes. Ecology and Society 12. https://doi.org/10.5751/ES-02092-120206
Nie, M., 2008. The underappreciated role of regulatory enforcement in natural resource conservation. Policy Sci 41, 139–164. https://doi.org/10.1007/s11077-008-9060-4
Olsson, P., Folke, C., Berkes, F., 2004. Adaptive Comanagement for Building Resilience in Social?Ecological Systems. Environmental Management 34. https://doi.org/10.1007/s00267-003-0101-7
Ostrom, E., 2009. A General Framework for Analyzing Sustainability of Social-Ecological Systems. Science 325, 419–422. https://doi.org/10.1126/science.1172133
Ostrom, E., 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press.
Pattengill-Semmens, C.V., Semmens, B.X., 2003. Conservation and Management Applications of the Reef Volunteer Fish Monitoring Program, in: Melzian, B.D., Engle, V., McAlister, M., Sandhu, S., Eads, L.K. (Eds.), Coastal Monitoring through Partnerships. Springer Netherlands, Dordrecht, pp. 43–50. https://doi.org/10.1007/978-94-017-0299-7_5
Patton, M.Q., 2002. Two Decades of Developments in Qualitative Inquiry: A Personal, Experiential Perspective. Qualitative Social Work 1, 261–283. https://doi.org/10.1177/1473325002001003636
Reid, R.S., Scharf, V.L., Huayhuaca, C., Lynn, S., Loyd, K., Jandreau, C., 2010. Collaborative conservation in practice: Current state and future directions. COLLABORATIVE CONSERVATION.
Sayre, N.F., 2017. The Politics of Scale: A History of Rangeland Science. University of Chicago Press, Chicago, IL.
Shackleton, C.M., Willis, T.J., Brown, K., Polunin, N.V.C., 2010. Reflecting on the next generation of models for community-based natural resources management. Envir. Conserv. 37, 1–4. https://doi.org/10.1017/S0376892910000366
Sheridan, T.E., 2007. Embattled Ranchers, Endangered Species, and Urban Sprawl: The Political Ecology of the New American West. Annual Review of Anthropology 36, 121–138.
Sheridan, T.E., Sayre, N.F., Nabhan, G.P., 2014. Beyond “Stakeholders” and the Zero-Sum Game: Toward Community-Based Collaborative Conservation in the American West, in: Stitching the West Back Together. University of Chicago Press.
Souther, S., Loeser, M., Crews, T.E., Sisk, T., 2019. Complex response of vegetation to grazing suggests need for coordinated, landscape-level approaches to grazing management. Global Ecology and Conservation 20, e00770. https://doi.org/10.1016/j.gecco.2019.e00770
West, N.E., 2003. History of Rangeland Monitoring in the U.S.A. Arid Land Research and Management 17, 495–545. https://doi.org/10.1080/713936110

Whitelaw, G., Vaughan, H., Craig, B., 2003. Establishing the Canadian Community Monitoring Network. Environmental monitoring and assessment 88, 409–418.
Wilmer, H., Derner, J.D., Fernández-Giménez, M.E., Briske, D.D., Augustine, D.J., Porensky, L.M., 2018. Collaborative Adaptive Rangeland Management Fosters Management-Science Partnerships. Rangeland Ecology & Management 71, 646–657. https://doi.org/10.1016/j.rama.2017.07.008
Wondolleck, J.M., Yaffee, S.L., 2000. Making Collaboration Work: Lessons From Innovation In Natural Resource Management. Island Press.
Woods, S.R., Ruyle, G.B., 2015. Informal Rangeland Monitoring and Its Importance to Conservation in a U.S. Ranching Community. Rangeland Ecology & Management 68, 390–401. https://doi.org/10.1016/j.rama.2015.07.005
Wright, P.A., Colby, J.L., Alward, G.S., 2002. Monitoring for forest management unit scale sustainability: the Local Unit Criteria and Indicators Development (LUCID) test, Management edition. ed, USDA FS IMI report. U.S. Dept. of Agriculture, Forest Service, Inventory and Monitoring Institute, Fort Collins, CO.
Wurtzebach, Z.P., 2018. Knowledge Management for Adaptive Planning and Decision-making in Federal Land Mangement Agencies (Diss). Colorado State University.
Yaffee, S.L., Wondolleck, J.M., 2003. Collaborative Ecosystem Planning Processes in the United States: Evolution and Challenges. Collaborative Planning and Sustainable Resource Management: The North American Experience 31.
York, E.C., Brunson, M.W., Hulvey, K.B., 2019. Influence of Ecosystem Services on Management Decisions by Public Land Ranchers in the Intermountain West, United States. Rangeland Ecology & Management 72, 721–728. https://doi.org/10.1016/j.rama.2019.02.002

APPENDICES

APPENDIX 1 – INITIAL LIST OF RANCHER-LED COLLABORATIVES IN THE INTERIOR WEST

Arizona:
Altar Valley Conservation Alliance*
Malpai Borderlands Group (AZ/NM)*
Diablo Trust*

Colorado:
Chama Peak Land Alliance (CO/NM)

Idaho:
Idaho Rangelands Conservation Partnership
Owyhee Initiative
Central Idaho Ranchlands Network

Kansas:
Tallgrass Legacy Alliance

Montana:
Centennial Valley Association*
Rancher Stewardship Alliance*
Winnett ACES*
Madison Valley Ranchlands*
Big Hole Watershed Committee*
Blackfoot Challenge*
Rangeland Monitoring Group

Nebraska:
Sandhill Task Force

New Mexico:
Catron County Citizens Group

Nevada:
Stewardship Alliance of Northeast Elko
Shoesole
ROGER*
Winecup-Gamble Outcome Based Grazing

Utah:
West Box Elder Coordinated Resource Management
3 Creeks Grazing Project LLC

Wyoming:
Thunder Basin Grasslands Prairie Ecosystem Association

**indicates collaboratives that participated in the study and agreed to be identified as participants*

APPENDIX 2 – RANCHER-LED COLLABORATIVE INTERVIEW GUIDE

INTRODUCTION:

Before proceeding I will provide you the necessary information about this project and ask for your informed consent to proceed. If you have questions, please feel free to stop me at any point.

Thank you for agreeing to participate in this interview. The purpose of this interview is to gain a better understanding of why and how rancher-led collaborative groups do or do not collect and utilize ecological and socioeconomic data to make management decisions for your shared management area. In responding to the question, please respond in your role as a stakeholder on behalf of your collaborative group. I will make it clear which questions are asking you to respond from your individual perspective versus on behalf of your collaborative group.

We will do our best to remove any identifying information from any publications or presentations of the results of this research. However, we also recommend you avoid providing information that may be used to identify or may be personally damaging to you or others.

[read all information in Informed Consent form or allow participant to read the form, obtain informed consent]

As described in the Informed Consent, your participation in this study is completely voluntary. You may ask to stop the study at any point and may skip any questions without penalty.
Do you have any questions before we get started?

INTERVEIW GUIDE

The sub-questions are prompts to serve as follow up to the main questions should the interviewees not answer the question fully. This interview is intended to be approximately 1 hour.

To start I am going to ask a few basic questions about your role in this collaborative group before diving into the main question for this study.
(skip any of these questions if information has been received through email)

What is your full name?
What organization do you work for? And what is your title?
What is your role within the collaborative group?

> *What is your role in regard to possible data collection or management decisions made by the collaborative group?*

What collaborative group are you answering these questions for? How long has your collaborative group been active?

> *Approximately how many stakeholders actively participate?*
> (Active participation: regularly attend meetings, part of the shared management area, provide insight or capacity, etc.)

Thank you for sharing some important background information on yourself. We will now dive into the main questions to learn more about the history of your collaborative group, how management decisions are made and what information helps you to do so.

1. Can you tell me a bit about how your collaborative group came together? What are your collaborative groups goals and objectives? Q2
   (do research prior to interview to find goals and objectives if they exist online)

2. Now can you talk me through how your collaborative group make management decisions for your shared management area? Q2 Q3

3. Does your collaborative group use data and information to track and monitor progress toward your goals and objectives, both ecological and socio-economic, for your shared management area? Q1 Q2 Q3
   IF THEY DO NOT USE DATA TO TRACK OR MONITOR, SKIP TO SEPARATE QUESTIONS AT THE END

4. Could you tell me about what drove your collaborative group to start collecting data and information? And why your collaborative group is currently collecting data and information? Q1

5. How does your collaborative group decide what data and information to collect to track and monitor progress toward your goals and objectives of your shared management area? Q1 Q2
   5.1. Did your collaborative group use any pre-existing protocols, guidelines or manuals in your initial data development? Were those tools helpful? (Read examples: such as Rangeland health indicator, AIM, etc.)
   5.2. Is any of it required data?

6. Does your collaborative collect data and information on both private and public land in your shared management area? If yes, how does the process to gather and monitor on private versus public land differ? Q1 Q2
   6.1 If no, how does your collaborative group make management decisions on the land type that you are not collecting data and information on?

7. What is your collaborative groups current capacity to collect and analyze the data and information for your shared management area? Do you utilize partner (or stakeholder) organizations or outside sources to help with that process? Q1
   7.1. Have you found any technology platforms helpful?
   7.2. How does your collaborative group fund data collection, analysis, and management?

8. How is monitoring data and information used to make management decisions for your shared management area by your collaborative group? How is it used outside of management decisions as well? Q3
   8.1. If it's not used for management decisions, why not?
   8.2. What types of monitoring data and information are the most useful in making management decisions?
   8.3. Are there ways your collaborative group would prefer to be using the data that the group is not currently?

9. Does your collaborative group use informal information, such as observations from ranchers or range riders to make management decisions? If so, why? And how so? Q3

We've discussed monitoring data and information in your management decisions and you've noted some of the complexity to do so, I will now ask a few questions about the strengths and barriers for your collaborative group as it relates to monitoring data and information and management decisions for your shared management area.

10. What are some of the strengths and weaknesses of your collaborative group's monitoring data and information collection, analysis and management? Q1

11. What are some of the strengths and weaknesses to utilizing your collaborative group's monitoring data and information to make management decisions for your collaborative group? Q2 Q3

SEPARATE QUESTIONS FOR THOSE THAT DO NOT COLLECT DATA
Thank you for sharing some important background information on your collaborative group. There are a number of groups like yours that do not collect data and information and, in an effort to learn more about how collaborative groups work across the west, the questions to follow will focus on what information your collaborative group uses to assist in making decisions.

3. What information does your collaborative group use to make management decisions for your shared management area? Q1

4. Does your collaborative group use informal information, such as observations from ranchers or range riders to make management decisions? If so, why? And how so? Q1

5. Has your collaborative group ever considered collecting data to track your process? Or been approached by an outside source to do so? Q1

6. If the opportunity arose, would your collaborative group be in interested to be collecting data and creating a monitoring plan? Q1 Q2 Q3

7. What are some of the strengths and weaknesses of your collaborative group's management decision-making process? Q1

Thank you so much for your input. I have finished with most of my questions, but before we go, I wanted to ask:

Is there anything else you would like to add?

Do you have any questions for me?

Do you have suggestions for other collaborative groups I should reach out to about this research project?

APPENDIX 3 – REQUEST TO PARTICIPATE OUTREACH

INITIAL EMAIL

Hello [Collaborative Group Main Contact(s)],

My name is Michaela Gold and I am a Master's student at Northern Arizona University in the Environmental Science & Policy program conducting research on collaborative groups in the Interior Western US that are specifically founded and/or run by ranchers. This research will look at how these collaboratives do or do not track and/or monitor progress to reaching their ecological and socioeconomic goals and objectives, and how that information is or isn't utilized to make management decisions for their collaborative groups shared management area.

The primary goals of this project include:

- Identify and assess the efforts of collaborative groups across the Interior Western US founded and/or run by ranchers to track and/or monitor their progress
- Identify themes of common collaborative needs in terms of collecting, analyzing, and using data and information to make management decisions
- Report outcomes and provide recommendations to collaborative groups to address identified needs

In order to gain these insights, I will be conducting interviews with each collaborative group that agrees to participate. I intend to conduct one interview per collaborative group with one member or a small group of members that have the most in-depth knowledge about your collaborative group's management processes. Your collaborative group has been identified to fit within the parameters for this research project as a (1) community-based collaborative, (2) started by one or more ranchers, and (3) including at least one working ranch grazing on public land. As members of [Name of Collaborative], we'd like to invite you and your collaborative to participate.

Your involvement within this process would consist of:

1. Participate in a 1 hour interview *over zoom* to discuss the collection (or no collection) of data by your collaborative group to track and/or monitor your progress and the utilization of that data to make management decisions in your shared management area. This interview can be with either yourself or an individual you feel has a better understanding of the group's management decisions and monitoring efforts. This interview will ideally be scheduled between May 31 to August 31 2021.
2. If applicable (i.e., your collaborative does collect data), provide a list of monitoring data variables being collected by your collaborative group and why they are being collected. (If you agree to participate I will provide more specifics about what is being requested for this item in a follow-up email.) Pulling together this information should take no more than 1-2 hour. This list will ideally be provided by August 31, 2021.

If your group is able to participate in this research project, please respond to this email confirming your collaborative's participation. I will follow up to schedule an interview and, if applicable, provide more specifics to provide the list of variables being collected by your collaborative group.

Even if you are unable to participate in the interview, I hope you would be willing to provide a list of the variables your collaborative group collects.

The goal of my work is to support community-based collaborative groups that engage ranchers and public land managers in the Interior West. To this end, I will provide a final project report to your collaborative group following completion of the project, in Spring 2022, and would be happy to set up a time to discuss the results. I also hope to provide a short fact sheet of the main outcomes, including the similarities and differences among monitoring programs for participating collaboratives, to share with both your collaborative group and the collaborative conservation field to help improve future recommendations for management plans in regard to what a group might consider collecting.

If you have any questions, please feel free to reach out to me directly at msg346@nau.edu or 650-353-1341. I am also more than happy to hop on a short phone call to explain a bit more about this research project should you like more information before agreeing to participate.

Thank you,
Michaela Gold

INSTRUCTIONS AFTER AGREEING TO PARTICIPATE

Hello [Main Contact(s)]

Thank you for agreeing to participate in this research project for [Collaborative Group Name]! The information you provide will be extremely helpful to bridging current gaps in our knowledge and helping to determine the successes and challenges to collecting and utilizing data to make management decisions for collaboratives to reach their goals and objectives.

SCHEDULE YOUR INTERVIEW
Please select the times you are available for a 1 hour interview block at this link: [INSERT LINK]
I will send along an email and calendar invite to confirm the time of the interview based on your availability. If you would prefer a different time please just let me know, I want to be as flexible as possible with your busy schedule.
The goal of this interview is to understand your groups history of collecting (or not collecting) data and how that data is or is not used to make management decisions, because of this please let me know if you think another member of your collaborative group should be interviewed or if you would like to have a few participants from your collaborative group participate in a small group interview.

SPREADSHEET OR PRE-EXISTING DOCUMENTS FOR LIST OF MONITORING DATA VARIABLES BEING COLLECTED:
As mentioned in the initial email, I am hoping to collect information on what variables are being collected by collaborative groups. In order to do so I am hoping you can provide, to the best of your ability, all the monitoring data variables collected by your collaborative group both past and present in your shared management area. A template excel spreadsheet has been attached to this

email to fill in this information, though you are welcome to use whatever format will be easiest for you to provide the information.

Please include the following, if available:
(1) Name of specific variable; (2) Type of data (social, ecological, economic); (3) What is being collected for this variable?; (4) Why is this data being collected? (5) Is it collected on public land, private land, both, or n/a; (6) How often is the data collected?; (7) Who collects this data? (8) Who analyzes the data?; (9) What is the data used for? (10) Are you required to collect this data? If so, by whom?; (11) Do you currently collect this data? If not, when did you stop collecting it?

If you have an already existing document that answers any or all of these questions feel free to send those along, I certainly do not want to have you recreate materials that already exist! The information you provide will be used mainly to determine the similarities and differences of variables being collected by collaborative groups and how closely aligned the data being collected is to a group's management goals and objectives. Please note that I am not requesting the actual data collected but rather the name of the variables.

The data from this spreadsheet will be coded so as to remove each collaboratives identifying information in the analysis and publication of this research study.

If possible, please provide the list of monitoring data variables by August 15th 2021.

Please let me know if you have any questions or need clarification on the intentions of this research project in regard to the interview or list of variables being requested.

Cheers,
Michaela Gold
msg346@nau.edu
650-353-1341

APPENDIX 4 – SUPPLEMENTAL EXAMPLE QUOTES OF INTERVIEW TRENDS

“You know that kind of stuff that's made us infinitely better about knowing even what questions to ask” (1, C-A)
“Wouldn't it be neat if we could actually use this information when it came out the other side. And so that kind of tied it down to the management driven research versus just purely theoretical” (6, C-F)
“We wanted monitoring locations that actually correlated to management, not a randomly stratified site.” (14, C-L)
“Flexibility of just being able to do what we need to do so that we can make good decisions for the land.” (16, C-M)
“We think that it's really critical like what is the feedback from some of this monitoring and are we actually monitoring the right things.” (14, C-L)

Table 8. Examples of quotes on need for monitoring to make more informed decisions

“So if you do a point in time data collection and assess that and say that it's damaged, those are the kind of things that I don't think are helpful in making those assessments.” (10, C-S)
“That's how you can show the success of that program is like here's the changes that we're seeing over time, whether it be good, bad and the middle and how do you adjust.” (20, C-P)
“We like to see the trends and we like to see the impact of our projects on the trends from that remote sensing.” (7, C-G)
“The problem is agencies don’t have the time to go out more often, so they are making the decision on your permit based on one data collection, which could be a particularly bad day” (10, C-S)

Table 9. Examples of quotes on the importance of data trends

“The cycle times on the research of trying to pose the original question, transforming it into something that's researchable, doing the data collection and then producing the final product at the end and that just takes time.” (6, C-F)
“Pace is too slow to come out for ranchers to make management decisions quickly… but it support decisions, maybe that they've made in the past by looking at the long term.” (9, C-I)
“[The data] is a little more time sensitive, even though we get it in January, by then, we all know, the ranches know what's going on right. But it's a good quick shot for defense.” (18, C-O)
“If you go look at a project after it's done a year later, you might be able to start getting some data. But ultimately three, four or five years later, is when you actually start seeing the results of your projects.” (3, C-C)

Table 10. Examples of quotes on the challenges of the timing of data

“We don’t have the capacity right now to be able to continue to do the monitoring.” (3, C-C)
“We definitely need more money to do more of this.” (8, C-H)
“Yes, both groups would be interested if capacity and funding wasn’t an issue.” (10, C-J, C-S)
“Even monitoring that is specifically required to administer that grazing permit is often not completed by the agencies.” (11, C-R)

Table 11. Examples of quotes on lack of capacity for collaboratives to do monitoring

“How are you going to collect data from multiple states where everything has to be done differently. And I think you're making it harder by doing that, but it's also really cool to see it from that big state level on how it's going to impact.” (20, C-P)
“We are interested to help share data if possible with these larger areas but us taking anything on like that would just overwhelm us as of right now.” (3, C-C)

Table 12. Examples of quotes on challenges to combining and “scaling up” data

“Usually, I'll see the ranchers and they'll tell me what's happening on their land.” (4, C-D)
“Maybe [the] landowner has an important observation or it's a recurring theme and I try to catalog those in my mind.” (8, C-H)
“They noticed something and they're telling us what's going on, so we can all problem solve kind of together.” (20, C-P)

Table 13. Examples of quotes on informal observations from ranchers

“We have really good agency folks overall but you know I think a lot of it is just learning and building those relationships. So, once they turn over then you have to start over.” (4, C-D)
“The time that we spend working with agency folks having conversations just affects the tone of the valley, it affects how people treat one another, it affects how agency folks approach [ranchers], it affects how we approach agency folks and it affects how other researchers come out here.” (1, C-A)
“As long as it isn't like latency sensitive or complicated and in like sharing agreement, yeah, I can ask and it usually shows up that day. I think the most successful part of what we do is it's been a very open and transparent group of involved partners, so I think very willing to help for the common cause.” (2, C-B)

Table 14. Examples of quotes on the importance of trust for shared monitoring

“Researcher[s] can come to us and say hey here's the project that we have lined out, kind of take a look at it first you know and say what do we think about this and what might be a problem.” (1, C-A)
“I end up you know kind of bridging the local community with our research partners it's a…very collaborative nature.” (6, C-F)
“We can't do everything, we can only do a tiny bit… so, finding those partners and trying to make those connections, I think, is really important.” (8, C-H)
“I kind of become a middleman and a liaison between rancher’s interests and an agency's interests and try to help understand each other what the other one needs.” (16, C-M)

Table 15. Examples of quotes on collaboratives serving as a middleman or facilitator

“It is amazing how different thing you know the big pressing issues can be depending on what the land ownership is.” (1, C-A)
“But I don't see it being viable or even worth the effort to try to somehow you know use that public data. As much as possible, we just want the federal entities to move as fast as they can, you know it's frustrating enough just sort of sitting and waiting for them.” (12, C-K)
“[The collaborative] has a project list… a lot of those are on public lands. So NEPA you know everything's bogged down… so all the projects that have been accomplished so far been on private land and each individual ranch has made that happen.” (17, C-T)

Table 16. Examples of quotes on the challenges of different landownerships for monitoring